697

FREQUENCY AND TIME MEASURING INSTRUMENT TYPE TSA3436/2

Instruction Manual

VENNER ELECTRONICS LIMITED
KINGSTON BY-PASS NEW MALDEN SURREY MALDEN 2442
A member of the Venner Group of Companies

A 697

FREQUENCY AND TIME
MEASURING INSTRUMENT
TYPE TSA3436/2

Instruction Manual

WITHOUT OUR PERMISSION THIS DRAWING / SPECIFICATION/DOCUMENT/REPORT WHICH IS OUR COPYRIGHT MAY NOT BE REPRODUCED OR MADE AVAILABLE TO THIRD PARTIES.
© 1965 VENNER LIMITED

VENNER ELECTRONICS LIMITED

Kingston By-Pass New Malden Surrey England
Telephone: MALden 2442. Ref: NA/BE/JP/5.65

CONTENTS

		Page No.
1	Introduction	1
2	Specification	2
	2.1 Power Supply	2
	2.2 Maximum D.C. Component of Input Signal	2
	2.3 Frequency Function	2
	2.4 Period Function	3
	2.5 Count Function	3
	2.6 Timing Function	3
	2.7 Start & Stop Inputs (external gating)	3
	2.8 Reset Signals	4
	2.9 External (Crystal) Reference Input	4
	2.10 Binary Coded Decimal Output (1-2-4-2' code)	4
	2.11 Standard Frequency Output	5
	2.12 Display Time	5
	2.13 Temperature Range	5
	2.14 Dimensions & Weight	5
3	Arrangement of Operating Controls	6
	3.1 Front Panel	6
	3.2 Rear Panel	6
4	Operating Instructions	7
	4.1 Mains-Voltage Setting	7
	4.2 Connection of Supply	8
	4.2.1 Mains	8
	4.2.2 Battery	8
	4.3 Checking Indicator Displays	8
	4.4 Test Facility	10
	4.5 Frequency Function	11
	4.5.1 Principle of Operation	11
	4.5.2 Measurement Procedure	11
	4.6 Period Function	12
	4.6.1 Principle of Operation	12
	4.6.2 Measurement Procedure	13
	4.7 Count & Timing Functions	13
	4.8 Reset Signals	16
	4.9 Standard Frequency Output	16
	4.10 External Reference Facility	16
	4.11 Binary Coded Decimal Output Facility	18
5	Maintenance	19
	5.1 Indicator Lamp Replacement	19
	5.2 H.T. Control	20
	5.3 Oscillator Trimmer	21
6	Circuit Description	21
	6.1 Stage Complement, Diagrams & Notation	21
	6.2 Power Supplies	22
	6.3 Oscillator	23
	6.4 First Frequency Divider Chain	24
	6.5 Second Frequency Divider Chain	25
	6.6 Input Circuit	25
	6.7 Gating Circuit	26

CONTENTS

Page No.

1 Introduction 1

2 Specification 2

2.1 Power Supply 2
2.2 Section No2. Components of Input Signal 2
2.3 Frequency Function 3
2.4 Period Function 3
2.5 Count Function 3
2.6 Timing Function 3
2.7 Start & Stop Inputs (external gating) 3
2.8 Reset signals 4
2.9 Reference (Crystal) Reference Input 4
2.10 Stores Coded Decimal Output (1-2-4-8 code) 4
2.11 Printed Circuitry Output 5
2.12 Display Tube 5
2.13 Temperature Range 5
2.14 Dimensions & Weight 5

3 Arrangement of Operating Controls 6

3.1 Front Panel 6
3.2 Rear Panel 6

4 Operating Instructions 7

4.1 Safety-Fuse Setting 7
4.2 Connection of Supply 8
4.3 Inputs 8
4.3.1 Scale 8
4.3.2 Timing 8
4.4 Operating Indicator Displays 9
4.4 Test Facility 10
4.5 Frequency Function 11
4.5.1 Principle of Operation 11
4.5.2 Measurement Procedure 11
4.6 Period Function 12
4.6.1 Principle of Operation 12
4.6.2 To measure Procedure 13
4.7 Count & Timing Functions 13
4.8 Reset Signals 14
4.9 Internal Frequency Output 15
4.10 External Reference Facility 15
4.11 Stores Coded Decimal Output Facility 16

5 Maintenance 19

5.1 Digitator Lamp Replacement 19
5.2 H.T. Control 20
5.3 Variable Trimmer 21

6 Circuit Description 21

6.1 Block Diagram, Diagram & Notation 21
6.2 Power Supplies 22
6.3 Decimator 23
6.4 First Frequency Divider Chain 24
6.5 Second Frequency Divider Chain 25

CONTENTS (Contd.)

		Page No.
6.8	Counter Chain & Indicators	27
6.9	Operation for Frequency Function	27
6.10	Operation for Period Function	28
6.11	Standard Frequency Output	29
6.12	Display Timing & Reset Zero Circuit	29
6.13	Reset Nine Circuit	30
6.14	Blanking Circuit	30
6.15	B.C.D. Output Circuit	32
7	Circuit References	33
7.1	Circuit ES66/16 (Main Circuit) Reference	33
7.2	Circuit E32/77 (TPC60) Reference	36
7.3	Circuit E32/78 (TPC61) Reference	37
7.4	Circuit E32/84 (TPC60/1) Reference	38
7.5	Circuit E32/98 (TPC61/1) Reference	39
7.6	Circuit E32/99 (TPC62/1) Reference	40
7.7	Circuit E66/15 (TPC67) Reference	41
7.8	Circuit E66/9 (TPC34) Reference	43
7.9	Circuit E66/17 (TPC20) Reference	44
7.10	Circuit E66/18 (TPC17) Reference	45

Illustrations

Layout of TSA3436/2 (following page 45)	Figure 1
TSA3436/2 Main Circuit Diagram	Drg. No. ES66/16
Double MF Decade Unit Type TPC60	" E32/77
HF/MF Decade Unit (divider) TPC61	" E32/78
Double MF Decade Unit Type TPC60/1	" E32/84
HF/MF Decade Unit (counter) Type TPC61/1	" E32/98
Crystal Oscillator Unit Type TPC62/1	" E32/99
Pulse Shaper & Gate Unit Type TPC67	" E66/15
Blanking Circuit Unit Type TPC34	" E66/9
Power Supply Group Board Type TPC20	" E66/17
B.C.D. Buffer Type TPC17	" E66/18

CONTENTS (Cont'd.)

Para No.

6.8 Counter Chain & Indicators 27
6.9 Operation for Frequency Function 27
6.10 Operation for Period Function 28
6.11 Standard Frequency Output 29
6.12 Display Timing & Reset Zero Circuit 29
6.13 Reset Pulse Circuit 30
6.14 Blanking Circuit 30
6.15 D.C.V. Output Circuit 32

7 Circuit Performance 33
7.1 Circuit TB65/16 (Main Circuit) Reference 33
7.2 Circuit X12/77 (TB06) Reference 36
7.3 Circuit E39/78 (TB08) Reference 37
7.4 Circuit X12/84 (TB09/1) Reference 38
7.5 Circuit E37/38 (TB08/1) Reference 39
7.6 Circuit X12/89 (TB08/1) Reference 40
7.7 Circuit B66/16 (TB07) Reference 41
7.8 Circuit B66/9 (TB03) Reference 43
7.9 Circuit B66/17 (TB10) Reference 44
7.10 Circuit B66/10 (TB11) Reference 45

Illustrations

Layout of TB43/45/2 (Foldover page 45) Page 4
TB43/45/2 Main Circuit Diagram Drg. No. B66/16
Double 4Y Decade Unit Type TB060 " E32/77
HF/4Y Decade Unit (Divider) TB061 " E37/78
Double 4Y Decade Unit Type TB060/1 " E32/84
HF/4Y Decade Unit (counter) Type TB061/1 " E32/89
Crystal Oscillator Unit Type TB065/1 " E39/38
Pulse Shaper & Gate Unit Type TB067 " B66/15
Blanking Circuit Unit Type TB035 " B66/9
Power Supply Group Board Type TB080 " B65/17
D.C.V. Buffer Type TB017 " B66/16

1. INTRODUCTION

The 'TSA three-four-three-six-mark-two' is a compact portable instrument designed to measure the frequency of signals up to 1.2 Mc/s and the period of signals up to 100 kc/s: the unit may also be operated as a counter or timer. Measurements are displayed by six in-line in-plane digital indicators; binary coded decimal output facility may be fitted as an optional extra.

For each of the functions Frequency and Period switched ranges are provided. On Period function, measurements can be recorded over a duration equal to 1, 10 or 100 cycles of the input waveform.

The instrument may be set for successive measurements to be made automatically, each readout being displayed for a period adjustable between approximately 1 and 5 seconds; alternatively, a measurement may be made and the display retained until a reset push button is operated. A Blanking switch determines whether the indicator numerals are displayed during the process of measurement.

Any one of eight standard frequency outputs may be selected and the gating and reset circuits can be controlled by external signals.

Self testing facilites are incorporated in the TSA3436/2 which employs transistorized printed circuit stages. An oven-controlled crystal oscillator serves as internal reference source: provision is made for the use of an external reference source.

The instrument is contained in a light grey P.V.C. covered dual-sectioned case; recessed front and rear panels are finished in light French blue. The carrying-handle is designed for use as a stand and thus enables the unit to be inclined for convenience of operation and viewing.

1. INTRODUCTION

2. SPECIFICATION

2.1 POWER SUPPLY

Mains:	100/125V, 40-60 c/s
	or
	200/250V, 40-60 c/s
	(Mains adjustment by tap on transformer: see Section 4.1)
	Consumption approx. 32W
Battery:	12V d.c.
	Consumption approx. 22W

2.2 MAXIMUM D.C. COMPONENT OF INPUT SIGNAL

400V (Permissible on A.C. Input setting only)

2.3 FREQUENCY FUNCTION

Ranges:	A.C.: 15 c/s to 1.2 Mc/s
	D.C.: D.C. to 1.2 Mc/s
Accuracy:	$\pm$ 1 count $\pm$ crystal stability Crystal frequency : 1 Mc/s
	Crystal stability : $\pm$ 1 part in 10^6
Signal Specification:	A.C.: Min. amplitude 100mV r.m.s.
	Max. amplitude 250V r.m.s.
	D.C.: Max. amplitude $\pm$ 50V peak
	Trigger level -2V max.
Input Impedance:	A.C.: 100kΩ shunted by 60pF
	D.C.: 10kΩ shunted by 120pF
Gatimg Times(selectable):	0.1, 1, 10 seconds
Count Capacity:	999,999

2.4 PERIOD FUNCTION

Ranges:	A.C.: 15 c/s to 100 kc/s D.C.: D.C. to 100 kc/s
Accuracy:	As stated in Section 2.3
Signal Specification:	As stated in Section 2.3
Input Impedance:	As stated in Section 2.3
Gating Times(selectable):	1,10,100 cycles of input frequency
Time Units:	1µS to 100mS in decade steps
Count Capacity:	999,999

2.5 COUNT FUNCTION

Count Capacity:	999,999
Ranges:	A.C.: 15 c/s to 1.2 Mc/s D.C.: D.C. to 1.2 Mc/s
Signal Specification:	As stated in Section 2.3
Input Impedance	As stated in Section 2.3

For control signals (start & stop) see Section 2.7

2.6 TIMING FUNCTION

Range:	1µS to 100,000 seconds (approx. 1.1 days)
Accuracy:	As stated in Section 2.3
Time Units:	1µS to 100mS in decade steps

For control signals (start & stop) see Section 2.7

2.7 START & STOP INPUTS (external gating)

Signal Amplitude:	5V to 10V positive pulse
Max. Rise Time:	0.2µS
Min. Pulse Width:	0.5µS
Input Impedance: (each line)	approx. 5kΩ in series with 200pF

2.8 RESET SIGNALS

Input:	Signal amplitude:	5V positive pulse
	Max. rise time :	approx. 20µS
	Min. pulse width:	approx. 100µS
	Input impedance :	approx. 2kΩ
Output:	Signal amplitude:	4V negative pulse
	Pulse rise time :	approx. 10µS
	Pulse width :	approx. 200µS
	Output impedance:	approx. 500Ω

2.9 EXTERNAL (Crystal) REFERENCE INPUT

Signal amplitude:	1V to 3V r.m.s.
Frequency :	1 Mc/s for standard functions. For non-standard functions frequency range: 200 kc/s to 1.2 Mc/s (Refer to Section 4.10)
Input Impedance :	1MΩ shunted by 120pF.

2.10 BINARY CODED DECIMAL OUTPUT (1-2-4-2' code)

	Output Impedance (approx.)	Min. Load Resistance*	Open Circuit d.c. levels* (approx.
Digit Lines:-			
Least-significant-digit :	6kΩ	25kΩ	Mark : -8V
			No mark : -2.8V
Other digits :	2kΩ	25kΩ	Mark : -7.3V
			No mark : -2V
Print Command :	2kΩ	2kΩ	Print : -7.3V
			Stand-by : -2.2V
Reset In :	Refer to 'Input' in Section 2.8		

---

* With respect to chassis-earth

2.11 STANDARD FREQUENCY OUTPUT

Output Frequency: Dependent upon setting of Function Selector switch, viz:-

Switch Setting		Std. Frequency	Mark/Space Ratio (approx.)
Frequency	X0.1	0.1 c/s	1 : 4 (-ve pulse)
	X1	1 "	" "
	X10	10 "	" "
Period	100mS	10 "	" "
	10mS	100 "	" "
	1mS	1 kc/s	" "
	100µS	10 "	" "
	10µS	100 "	See note below
	1µS	1 Mc/s	1 : 1

(Note. 100 kc/s: positive-going pulses approx. width 2µS)

Signal amplitude : approx. 5V

Output impedance : approx. 2kΩ

2.12 DISPLAY TIME

'Auto' setting : adjustable between approx. 1 and 5 seconds

'Manual' " : display retained until reset push button is pressed.

2.13 TEMPERATURE RANGE

0° to $+40^{\circ}$ Centigrade

2.14 DIMENSIONS & WEIGHT

Width	Height	Depth (front to rear)	Weight
$14\frac{1}{4}$"	$3\frac{7}{8}$"	$10\frac{1}{2}$"	13lbs
(36cm)	(10cm)	(27cm)	(5.9 kg)

3. ARRANGEMENT OF OPERATING CONTROLS

3.1 FRONT PANEL

To the right of the display screen is the 10-position Function Selector. The extreme anti-clockwise setting of this switch serves as an 'OFF' position when the instrument is fed by mains.* The next three positions marked X0.1 c/s, X1 c/s and X10 c/s, respectively, are for use on Frequency function; the remaining six positions marked 100mS, 10mS, 1mS, 100µS, 10µS and 1µS, respectively, are for use on Period function.

On the right of the panel are mounted an 'A.C./Test/D.C.' selector switch, an 'A.C. Sensitivity' control and two signal input terminal sockets.

The following controls are mounted below the indicators.

Reset Zero switch(marked: Manual/Auto.) with Reset Zero push button
Display Time Control
Blanking switch
Period Cycles selector (positions: 1, 10, 100)
Reset Nine push button

3.2 REAR PANEL

On the left of this panel (unit viewed from rear) are mounted the following.

Gate Control switch(marked: Internal/External) with associated Start and Stop input sockets for use when the switch is set to Ext.
Chassis-earth socket
Reset Input and Output sockets
Standard Frequency output socket
Crystal Reference switch (marked: Internal/External) with associated external reference input socket for use when the switch is set to Ext.

---

* Note: For battery switching refer to Section 4.2.2

Fuse 0.5A (H.T. supply)
Mains/12V D.C. supply selector switch
12V D.C. input socket

An entry for the mains cable is provided in the left lower corner.

On the right of the panel Set Zero and Set Nine controls of the indicators are mounted in two rows.

Two cable-wrapping knobs and a cable clip are fitted on the panel to facilitate stowage of the mains cable when it is not in use.

4. OPERATING INSTRUCTIONS

4.1 MAINS-VOLTAGE SETTING

Check that the tapping selected on the internal mains transformer is suitable for the supply voltage. Access to the transformer may be gained by removing the lid of the instrument which is held in position by two screws, one at each side of the unit.

The wire connected to the 0V tag of the transformer should not be removed as this is the neutral supply line. The remaining wire, the live line, is provided as the moveable lead; this should be soldered to the tap most appropriate for the supply voltage.

In Figure 1 the tags are coded by the letters t - z; the following list associates them with their corresponding voltages.

Transformer (T1) References

t	=	0V (neutral supply line)
u	=	102V tap
v	=	112V "
w	=	122V "
x	=	205V "
y	=	225V "
z	=	245V "

Replace and secure the lid before connecting the mains supply.

4.2 CONNECTION OF SUPPLY

4.2.1 Mains

Having checked the voltage setting of the mains transformer (Section 4.1) proceed as follows.

(i) Set Function Selector to 'OFF'

(ii) Set Mains/12V D.C. switch to 'Mains'

(iii) Connect supply to the 3-core mains cable as below.

Red core	:	Mains live
Black "	:	Mains neutral
Green "	:	Earth

Clockwise rotation of the Function Selector to any one of the Frequency or Period positions switches 'ON' the supply within the unit for instrument operation.

4.2.2 Battery

(i) Set Mains/12V D.C. switch first to 'Mains'

(ii) Connect the 12V D.C. battery-supply to 3-pin rear-mounted socket as follows.

Viewed from rear of unit:

1st pin in anti-clockwise direction from locating inset : POSITIVE

" " " clockwise " " " " : NEGATIVE

For battery operation the Mains/12V D.C. switch may be used as an ON/OFF control; the battery-supply being fed to the internal circuit when the switch is set to the 12V D.C. position. Although current is then drawn from the supply the Function Selector must be set to one of the Frequency or Period positions for instrument operation.

4.3 CHECKING INDICATOR DISPLAYS

It is recommended that an initial check, and subsequent occasional checks, be made on the indicator displays.

To check the displays, the following switch settings should be established.

	Switch		Setting
Front:-	Reset Zero	:	Manual
	Blanking	:	OFF
	Function Selector	:	Any Frequency position
	A.C./Test/D.C.	:	D.C.

For each indicator a Set Zero and a Set Nine control are provided so that, when checking the display presentations, the figures 0 and 9 may in turn be set symmetrically about the vertical axes of the indicator frames. The 'Set Zero' potentiometers (RV1,3,5,7,9 & 11)* form a row of controls near the upper edge of the rear panel: in-line below these are the 'Set Nine' potentiometers (RV2,4,6,8,10 & 12).* Refer to Figure 1 for indicator-to-control relationship.

With no signals applied at the input terminals proceed as follows.

(i) Momentarily depress the Reset Zero push button to obtain the display:- '000000'
Check each '0' for symmetry: adjust Set Zero controls where necessary.

(ii) Momentarily depress the Reset Nine push button to obtain the display:- '999999'
Check each '9' for symmetry: adjust Set Nine controls where necessary.

(iii) Repeat procedures (i) and (ii) until symmetrical 0 and 9 displays are obtained without adjustments.

---

* Circuit daigram ES66/16 references

4.4 TEST FACILITY

In order that the counting and readout operations of the instrument may be periodically checked, provision is made for feeding 100 c/s output signals of the frequency divider chain to the signal input circuit.

Note: The Test function may be used while signals are present at the input terminals providing their amplitude does not exceed 10V peak: otherwise signal breakthrough may interfere with the test operations and give rise to incorrect counts.

To use this facility first set the switches as indicated below.

	Switch		Setting
Rear:-	Gate Control	:	INT
	Crystal Reference	:	INT
Front:-	Reset Zero	:	As Required
	Blanking	:	OFF
	A.C./Test/D.C.	:	Test

The following list shows the respective displays which should be obtained for the various settings of the Function Selector and Period Cycles switch.

Function Selector Setting			Display (Period Cycles switch: any position)
Frequency	X0.1	c/s :	001000 ± 1
"	X1	" :	000100 "
"	X10	" :	000010 "

		Period Cycles:-	Display X1	X10	X100
Period	100mS	:	000000 ± 1	000001 ± 1	000010 ± 1
"	10mS	:	000001 "	000010 "	000100 "
"	1mS	:	000010 "	000100 "	001000 "
"	100µS	:	000100 "	001000 "	010000 "
"	10µS	:	001000 "	010000 "	100000 "
"	1µS	:	010000 "	100000 "	000000 "

4.5 FREQUENCY FUNCTION

4.5.1 Principle of Operation

In this function the input signals are gated for a definite period determined by the setting of the Function Selector. The cycles of input frequency so gated are counted by a chain of six decades; the six indicators display the resultant count.

4.5.2 Measurement Procedure

(i) Set rear-mounted Gate Control and Crystal Reference switches to INT.

(ii) Select Manual or Auto. reset-zero by use of Reset Zero switch. If Auto. reset is selected, set Display Time control as required. (Display time for min. setting approx. 1 Sec., for max. setting approx. 5 Sec.)

(iii) Set Blanking switch to ON if no display is to be shown until the end of each measurement.

(iv) If B.C.D. output facility (on units having modification 'Z') is to be utilized, refer to Section 4.11.

(v) Select A.C. or D.C. input coupling by use of A.C./Test/D.C. switch. If 'A.C.' is selected turn A.C. Sensitivity control to MAX.

Note. This sensitivity setting is suitable for smooth-edged waveforms of amplitude 100mV to 250V r.m.s. When interference is present or the rising and/or falling waveform-edges are irregular (due to harmonic content) the sensitivity should be appropriately reduced if it is found, during a few initial measurements, that the instrument is triggered more than once in a cycle: the latter is manifested by abnormal counts.

(vi) Connect the input signal leads to the terminals(Red: 'high' signal line. Black: 'earth' line).

(vii) Set Function Selector to suitable range for measurement of input frequency. When order of frequency is unknown, use highest range (X10 c/s) first.

(viii) If Manual reset has been selected, momentarily depress Reset Zero push button to initiate a measurement. When Auto. reset is selected measurements are initiated automatically.

The gating times for the ranges are as follows.

10 Seconds	on	Frequency	X0.1
1 Second	"	"	X1
0.1 Second	"	"	X10

As each display is the count of input cycles received during the gating time, each readout should be multiplied by the appropriate range factor (0.1, 1 or 10); the result is a frequency measurement in cycles per second.

Note: It should be noted that it is possible to exceed the count capacity of the instrument during a measurement; this is dependent upon the input frequency and the range employed. The most significant digit indicator resets from 9 to 0 each time that the count capacity is exceeded.

Example:

A frequency of 1,000,002.3 c/s applied on the range Frequency X10 would produce the measurement 100,000* X10 c/s (i.e., 1 Mc/s). The same frequency applied on the range Frequency X1 would cause the count capacity of the instrument to be exceeded once during the measurement and give rise to the display 000002*. The most significant digit (M.S.D.) would not be shown but the extreme right hand indicator would display the 7th M.S.D.

Similarly, on the range Frequency X0.1 the count capacity of the instrument would be exceeded ten times during the measurement and a resultant display of 000023* would be shown.

4.6 PERIOD FUNCTION

4.6.1 Principle of Operation

In this function, the input signals control the internal gate which is held open for a time equal to 1, 10 or 100 periods of the input frequency (depending upon the setting of the Period Cycles switch). While the gate is open, pulses derived from the crystal oscillator (and of repetition rate determined by the setting of the Function Selector) pass via the gate to a six decade counter chain. The resultant count, which is displayed by the indicators, is therefore a measurement of the time for which the gate is held open and is thus a Period measurement of the input waveform.

---

* Subject to the accuracy quoted in Section 2.3

4.6.2 Measurement Procedure

Carry out procedures (i) to (vi), inclusive, of Section 4.5.2; then proceed as follows.

(a) Set Period Cycles switch to 1 (i.e., so measurement will be taken initially over 1 period of input waveform).

(b) Set Function Selector to suitable range. When order of signal period is unknown, use highest range (100mS) first.

(c) If Manual reset has been selected, momentarily depress Reset Zero push button to initiate a measurement. When Auto. reset is selected measurements are initiated automatically.

The count, registered while the gate is held open, is recorded in units of time indicated by the setting of the Function Selector*. The final display multiplied by the range factor gives the Period measurement in milliseconds or microseconds, depending upon the range selected.

Note: In this function as in the case of Frequency function, the count capacity of the instrument may be exceeded in recording a measurement.

With Period Cycles switch settings of 10 and 100 the resultant time displays are respectively ten times and one hundred times greater than the actual period of the input waveform. These switch settings are particularly useful for period measurement of high frequency signals.

Example:

A frequency in the order of 95 kc/s, having a period of 10.52 microseconds, applied on the 'Period 1μS' range would give rise to the display 000010**(μS) if measured over 1 cycle. However, the 3rd and 4th most significant digits (52) would be displayed if the measurement were taken over 100 cycles: the display would be 001052**(μS), thus indicating a signal period of 10.52μS.

4.7 COUNT & TIMING FUNCTIONS

The rear-mounted START and STOP input sockets, associated by engraving with the Gate Control switch, are used for functions Count and Timing.

---

* The Function Selector indications are also the respective repetition rates at which pulses are fed to the counter while the gate is held open.

** Subject to accuracy quoted in Section 2.3

With the switch set to 'INT', gating action is controlled internally and both input sockets are isolated from the functional circuit.

With the switch set to 'EXT' the gate is controlled externally; the gate is opened when a suitable signal* is presented between the START socket and the adjacent earth socket, and closed when a second such signal is presented between the STOP socket and the earth socket.

The START and STOP inputs may be linked together if single-line gate control operation is required. In such a case two successive signals presented (after the occurrence of reset action) between the link and the earth socket cause the gate to open and close respectively.

COUNT:

(i) Set Crystal Reference switch to INT.

(ii) Set Function Selector to any Frequency position and Blanking switch to OFF.

(iii) Select 'Manual' reset-zero; momentarily press Reset Zero push button.

(iv) If B.C.D. output facility (on units having modification 'Z') is to be utilized, refer to Section 4.11.

(v) Select A.C. or D.C. input coupling by use of A.C./Test/D.C. switch. If A.C. is selected turn A.C. Sensitivity control to MAX. and refer to 'Note' in Section 4.5.2.

(vi) Connect the input signal leads to the terminals (Red: 'high' signal line. Black: 'earth' line).

(vii) Set Gate Control switch to EXT and connect the gate control leads to the adjacent START, STOP and earth sockets.

(viii) Momentarily depress Reset Zero push button: the first external gate-control-signal* applied (after the occurrence of reset action) will cause the gate to open. Random input pulses (or cycles of an input frequency) applied to the input terminals will then be registered by the instrument; the number being displayed by the indicators (Note: count capacity 999,999). A second external gate-control-signal (stop-signal) should be applied if the count is required over a definite interval; in this case the Blanking and Auto. reset facilities may be used if required, refer Section 4.5.2 procedures (ii) and (iii).

---

* For signal specification refer Section 2.7

Count function may be utilized for the measurement of frequency ratio; the lower of the two frequencies concerned (f_L) being applied to the START and STOP inputs (connected for single-line gate control operation), the higher frequency (f_H) being applied to the input terminals on the front panel.

In such a case the gate is opened for a time corresponding to one cycle of f_L; the number of cycles of f_H occurring in this time is displayed by the indicators. The frequency ratio $f_L : f_H$ is:-

1 : Displayed Count

(Count accuracy: +0, -1)

Owing to the -1 digit count tolerance, the most accurate results will be obtained when f_H is in the order of 100 x f_L or greater: in certain cases better accuracy may be obtained by using the external reference facility for frequency ratio measurement; refer to Section 4.10.

TIMING OR PERIOD

(i) Set Crystal Reference switch to INT.

(ii) Select Manual or Auto reset-zero and Blanking as required; refer Section 4.5.2 procedures (ii) and (iii).

(iii) If B.C.D. output facility (on units having modification 'Z') is to be utilized, refer Section 4.11.

(iv) Set A.C./Test/D.C. switch to'D.C.'

(v) Set Gate Control switch to EXT and connect the gate control leads to the adjacent START, STOP and earth sockets (Note: No connections should be made at front panel mounted input terminals).

(vi) Set Function Selector to Period: the range most suitable for the order of the estimated time interval should be used. The switch markings indicate the respective time units in which the interval may be recorded.

(vii) Momentarily depress Reset Zero push button; then apply 'start' and 'stop' signals*.

The external gate-control-signals effectively replace the input signals normally applied at the input terminals. Signals derived from the internal oscillator pass to the counter during the interval between the first and second external gate-control-signals. This time is equal to the displayed count multiplied by the range factor and is given in milliseconds (mS) or microseconds (μS) as indicated by the range setting.

---

* For signal specification refer Section 2.7

Note: If use is made of this function for the measurement of signal period, note that measurements are recorded over one cycle of the input irrespective of the Period Cycles switch setting.

This function may be used for contact timing if contact actuation is arranged to produce suitable gate-control-signals. In certain cases circuits may be arranged so that, upon contact actuation, the potential of a battery is effective as a gate-control-signal.

4.8 RESET SIGNALS

Reset action within the unit may be initiated externally by applying a suitable signal* between the rear-mounted RESET IN socket and adjacent earth socket. For external triggering the Reset Zero switch should be set to the Manual position to prevent internal reset action occurring automatically.

An output pulse is produced at the RESET OUT socket* whenever reset action occurs within the instrument. This signal may be used to synchronize the resetting of other instruments, or external circuits, with that of the TSA3436/2.

4.9 STANDARD FREQUENCY OUTPUT

The frequency of signals produced at the rear-mounted Std. Frequency socket is dependent upon the setting of the Function Selector as indicated (together with signal details) in Section 2.11. Frequencies ranging, in decade increments, from 0.1 c/s to 1 Mc/s may be selected.

4.10 EXTERNAL REFERENCE FACILITY

When the rear-mounted Crystal Reference switch is set to INT, the adjacent input socket is isolated from the functional circuit and the internal 1 Mc/s crystal controlled oscillator is employed as reference source.

When the switch is set to EXT, the internal oscillator is switched out of circuit and signals applied to the crystal reference socket** serve as reference signals for the instrument.

This facility may be used incases where it is required to increase the accuracy of the instrument for the standard functions, or where it is required to alter the significance of the readout so

---

* For signal specification refer Section 2.8

** For signal specification refer Section 2.9

that the instrument will operate in a non-standard manner.

Frequency Ratio Measurement:

This facility may also be used to measure the frequency ratio of two repetitive waveforms, one of which should be applied to the input terminals the other to the EXT Crystal Reference socket. The latter waveform should conform to the specification given in Section 2.9: a square waveform may be applied providing the rise time is less than 10μS.

The following control settings should be established.

Crystal Reference switch	:	EXT
Gate Control switch	:	INT
Other controls (excluding Function Selector and Period Cycles switch)	:	As required

Depending upon the order of the frequency ratio, either Frequency function or Period function may be used for the measurement. The two functions will be treated separately.

(a) Frequency Function (Period Cycles switch inoperative)

With the Function Selector set to X10, X1 or X0.1 the frequency applied to the EXT Crystal Reference socket (f_E) passes to the contro input of the gate via divider stages having division factors of 10^5, 10^6 and 10^7 respectively. The frequency applied to the terminals (f_T) passes via the gate to the counter chain.

The frequency ratio $f_T : f_E$ is given by:-

$$1 : \frac{\text{Division Factor}}{\text{Displayed Count}}$$

Example:

With f_E= 500 kc/s; f_T= 20 kc/s and Function Selector set to 'X1' (i.e. division factor of 10^6):-

The gating time = $\frac{10^6}{500\,000}$ = 2 seconds.

Displayed count = 2 Sec. x 20 kc/s = 40,000

Hence the ratio is:-

$$1 : \frac{10^6}{40{,}000}$$

i.e. 1 : 25

(b) Period Function

With the Period Cycles switch set to X1, X10 or X100 the frequency applied to the input terminals (f_1) passes to the control input of the gate via divider stages having division factors of 1, 10 and 100 respectively.

The Period setting of the Function Selector determines the division factor to which the frequency applied at the EXT crystal Reference socket (f_2) is subjected before passing via the gate to the counter. The division factors for Function selector settings (shown in brackets) are as follows.

1(1μS); 10(10μS); 10^2(100μS); 10^3(1mS); 10^4(10mS); 10^5(100mS)

The frequency ratio $f_1 : f_2$ is given by:-

$$1 : \frac{\text{Displayed Count x Function Selector Division Factor}}{\text{Period Cycles Division Factor}}$$

Example:

With f_1 = 20 kc/s; f_2 = 500 kc/s; Function Selector set to '10μS' and Period Cycles switch set to 'X100' :-

$$\text{The gating time} = \frac{100}{20000} = \frac{1}{200} \text{ Sec.}$$

$$\text{Displayed count} = \frac{1 \text{ Sec.}}{200} \times \frac{500 \text{ kc/s}}{10} = 250$$

Hence the frequency ratio is :-

$$1 : \frac{250 \times 10}{100}$$

i.e. 1 : 25

Note: Control settings should be chosen such that the capacity of the counter is not exceeded. In general, maximum accuracy is achieved when the displayed count is the highest obtainable without exceeding the counter's capacity.

4.11 BINARY CODED DECIMAL OUTPUT FACILITY

This facility, classified as modification 'Z' and available as an optional extra, is incorporated only if ordered.

When the facility is incorporated, the letter Z is included in the type number of the instrument (e.g., TSA3436/2Z).

The B.C.D. outputs are produced (in 1-2-4-2' code) at a 36-pin Amphenol socket mounted on the rear panel above the battery input connector. The connections are as follows.

(Note: M.S.D. = most significant digit)

Pin No.	Output	Pin No.	Output	Pin No.	Output
1	6th M.S.D. 1	13	4th M.S.D. 4	25	Unused
2	" 2	14	" 2'	26	M.S.D. 1
3	" 4	15	Unused	27	" 2
4	" 2'	16	3rd M.S.D. 1	28	" 4
5	Unused	17	" 2	29	" 2'
6	5th M.S.D. 1	18	" 4	30	Unused
7	" 2	19	" 2'	31	Reset IN
8	" 4	20	Unused	32	Unused
9	" 2'	21	2nd M.S.D. 1	33	Print Command
10	Unused	22	" 2	34	Chassis-earth
11	4th M.S.D. 1	23	" 4	35	Unused
12	" 2	24	" 2'	36	"

Refer to Section 2.10 for signal specification.

Note: To ensure that data logging shall be completed before the instrument is reset, the recording time of the logging equipment must not exceed the minimum display time of the TSA3436/2.

5. MAINTENANCE

Notes: (1) The lid of the instrument may be lifted off after the two securing screws, situated one at each end of the case, have been removed.

(2) When the instrument is used with a mains supply and operation is required with the lid removed, care should be exercised to ensure that no physical contact is made with exposed connections; particularly those of the mains circuit in the region of the transformer and Function Selector.

5.1 INDICATOR LAMP REPLACEMENT

If an indicator lamp fails to function proceed as follows.

(i) Note faulty indicator; switch OFF and disconnect supply; remove lid of instrument.

(ii) Remove two 6 B.A. screws securing metal strip at top rear of indicator.
The strip which has a knurled knob at its centre forms the top of the lamp housing.

(iii) Lift out housing and fit new lamp (E.A.C. Digivisor lamp 12V 2.2W; Venner part No.Z27578). Two spare lamps are provided within the instrument; they are mounted in clips beside the Function Selector.

(iv) Replace housing but leave 6 B.A. screws loose in position.

(v) Set following controls as indicated.

Control		Setting
Function Selector	:	Frequency (any position)
A.C./Test/D.C. switch	:	D.C.
Reset Zero switch	:	Manual

(vi) Re-connect and switch ON supply: with no signals applied to input terminals, momentarily depress Reset Zero push button to obtain an all-zeros display.

(vii) Adjust horizontal position of lamp for even illumination of display by sideways movement of entire housing: when appropriate position is found, tighten 6 B.A. screws.
Adjust vertical position of lamp by turning knurled knob.

When the adjustments are completed replace and secure the instrument lid.

Note: Some indicators are fitted with a slotted black screw (7/16"D) on the top surface approximately $1\frac{1}{2}$" from the front panel.
The setting of this screw should NOT be altered.
The screw is a mechanical zero-centring control which is set, during manufacture, with the lamp illuminated and the deflection coil disconnected.

5.2 H.T. CONTROL

The voltage of the stabilized H.T. supply is determined by a preset potentiometer (RV1 on diagram E66/17) located above the Power Supply Group Board: See Figure 1.

In normal circumstances adjustment of the control should not be required. However, in the event of abnormal instrument operation, or when servicing the equipment, it is advisable to check the H.T. voltage and to adjust the control setting if necessary.

The H.T. voltage may be measured at top-row tags of the Power Supply Group Board. With the tags counted from the front panel towards the rear of the unit, a suitable voltmeter (e.g., AVO Model 8 set to the 10V d.c. range) should be connected between the 3rd tag (negative meter-terminal) and 4th tag (positive meter-terminal).

The H.T. supply should be 8.5V; if necessary the control setting should be adjusted for this value.

5.3 OSCILLATOR TRIMMER

The oscillator trimmer (referenced C1 on diagram E32/99) is incorporated in the printed circuit stage TPC62/1: see Figure 1. The control is preset for an oscillator frequency of precisely 1 Mc/s. The accuracy of the instrument is dependent upon this frequency and in normal circumstances no alteration should be made to the setting of the trimmer.

The oscillator frequency may be monitored at the rear-mounted 'Std. Freq. O/P' socket when the Function Selector is set to Period 1 µS. If at some time (e.g., after the instrument has given long service) frequency drift is found to have occurred, the trimmer should be adjusted for the necessary 1 Mc/s oscillator-frequency which may be checked by comparison with a suitable external standard frequency.

6. CIRCUIT DESCRIPTION

6.1 STAGE COMPLEMENT, DIAGRAMS & NOTATION

The main circuit of the instrument is illustrated by diagram ES66/16 which depicts eleven transistorized printed-circuit stages; for these, separate sub-circuit diagrams are provided.

The stages and their respective circuit diagram numbers are as follows.

Stage Type No.	Title	Diagram No.	Quantity
TPC34	Blanking Circuit	E66/9	1
TPC60	Double MF Decade (divider)	E32/77	2
TPC60/1	Double MF Decade (counter)	E32/84	2
TPC61	HF/MF Decade (divider)	E32/78	1
TPC61/1	HF/MF Decade (counter)	E32/98	1
TPC62/1	Crystal Oscillator Unit	E32/99	1
TPC67	Pulse Shaper & Gate Unit	E66/15	1
TPC20	Power Supply Group Board	E66/17	1
TPC17*	B.C.D. Buffer	E66/18	1

Certain component references (e.g., R1, C1 etc) occur on more than one diagram. To avoid ambiguity in the circuit description appearing in Sections 6.2 to 6.15 all component references pertaining to the main circuit diagram (ES66/16) are shown underlined (e.g., T1). Unless clearly indicated to the contrary, each reference of the transistorized printed circuit stages pertains to the circuit whose bracketed diagram number most closely precedes it in the text.

6.2 POWER SUPPLIES

Mains/Battery Input:

On the main circuit diagram (ES66/16) switch SF(1 & 2) is the Mains/12V D.C. supply selector.

The mains input cable is represented by the lines marked Red (supply 'live'), Black (supply 'neutral') and Green (earth).

Switch SA5 is the mains ON/OFF switch (ganged to the Function Selector) and capacitor C7 is an interference-suppressor. The mains supply is applied to the primary winding of transformer T1 via a pre-selected tap.

Socket SKT 'G' is the battery input connector.

H.T. Supply:

On mains operation the bridge-rectifier MR2 is fed by the 14V secondary winding of T1. The output of this full-wave rectifier passes via the fuse FS1 (0.5A) and is stabilized by a conventional series stabilizer circuit comprising transistor VT1, capacitor C8, and the circuit of the power supply group board (E66/17). The positive output-line of MR2 links with chassis-earth via the switch SF2.

---

* Fitted only for modification 'Z'.

In the circuit of the power supply group board the reverse breakdown voltage of a silicon Zener diode, MR1, is used as a reference potential for the emitter circuit of VT2. The collector current of this transistor controls the series stabilizers VT1 and VT1. The output, preset to 8.5V* by potentiometer RV1 effective in the base circuit of VT2, serves as H.T. supply for the instrument.

On battery operation MR2 is fed by the 12V D.C. input applied at socket SKT 'G'. In the bridge-rectifier, the diode connecting the negative supply-line to C8 ensures that current is supplied to the H.T. stabilizer circuit only in the event of correct connection of the 12V D.C. input. The supply effectively replaces the rectified transformer-output obtained on mains operation.

Oven Supply:

On mains operation the supply lines of the thermostatically controlled crystal oven (XX on main diagram) are fed by the output of transformer T1 via SF1 stator 2.

On battery operation the crystal oven is powered by the 12V D.C. input via SF1 stator 1.

Indicator Lamp Supply:

On mains operation bridge-rectifier MR3 is fed by the secondary winding of T1. The output of the rectifier (approx. 12V) supplies the lamp circuit which is treated in a later section of this manual. The positive output-line is linked to chassis-earth by switch SF2.

On battery operation MR3 is fed by the 12V D.C. input; the diode connecting the negative supply-line to the negative output line, protects the lamp circuit in the event of incorrect battery connection.

6.3 OSCILLATOR

The oscillator circuit (E32/99) is housed by the printed-circuit board TPC62/1 and incorporates transistor VT1 which operates in conjunction with the external oven controlled crystal XL1. The oscillator is trimmed for an operating frequency of 1 Mc/s by the preset capacitor C1.

When the Crystal Reference switch SC is set to 'INT', signals from the emitter load of VT1, available at TP23, are fed to TP25 and pass via an inverter, VT2, to a Schmitt trigger circuit comprising VT3 and VT4.

---

* Positive line to chassis-earth

Note: With the switch set to 'EXT' the oscillator is isolated and signals applied to the external crystal reference input socket SKT'H' pass via the inverter and Schmitt circuit.

Output signals of rectangular waveform (frequency 1 Mc/s) are produced at the collector of VT4 which is linked to terminal point TP17.

6.4 FIRST FREQUENCY DIVIDER CHAIN

This frequency divider chain consists of five cascade-connected decade circuits, the first two of which are housed by TPC61.

The 1 Mc/s signals from TP17 of the Schmitt trigger circuit (E32/99) feed the first or HF decade (E32/78) via its input point TP39. Basically the decade consists of four cascade-connected binary stages formed by transistors VT9-16; transistor VT17 serves as an output emitter follower, VT19 as feedback-pulse shaper, and VT18 as output pulse shaper/inverter.

The decade operates as a divide-by-ten stage and produces one positive-going pulse at the output, TP1, for every ten positive-going signals received at its input, TP39. Signals of frequency 100 kc/s are therefore produced at TP1; these signals are applied via C1 to the second decade which is formed by transistors VT1-8. The second or LF decade operates in a similar manner to that of the first or HF unit: however, being a lower frequency decade no stages corresponding to VT17-19 are required; the output is therefore derived from the final binary circuit (VT8 collector) connected to TP3 where signals of frequency 10 kc/s are produced.

These signals are supplied to the input point TP16 of the third decade (E32/99) which is housed by TPC62/1. The operation of this decade is similar to that of the second decade: output signals of frequency 1 kc/s are therefore produced at output point TP5.

The 1 kc/s signals are fed to the input point TP33 of the Double MF Decade Unit TPC60'a' (E32/77). This stage houses two cascade-connected decade circuits whose arrangements and operations are similar to those of the preceding decades. Signals of frequency 100 c/s are produced at the cascading-junction TP6, whilst signals of frequency 10 c/s occur at the final output point TP5.

6.5 SECOND FREQUENCY DIVIDER CHAIN

The second frequency divider chain consists of the two cascade-connected MF decades housed by TPC60 'b' (E32/77). The operations of the decades are identical to those of the decades housed by TPC60 'a'. In this case, however, the input point TP33 is fed with signals selected by the rotor of switch SA1 (a wafer of the Function Selector).

Signals at frequencies one-tenth and one-hundredth of the chain's input frequency are produced respectively at output points TP6 and TP5: the input frequency depends upon the function in which the instrument is set to operate; the functions are treated later in this manual.

6.6 INPUT CIRCUIT

The 'A.C./Test/D.C.' slide-switch SB(1-3) functions as circuit selector for Pulse Shaper and Gate Unit TPC67 (E66/15).

Within the unit, TP32 serves as input terminal point for emitter follower VT1 which feeds a.c.-coupled amplifier/inverter VT2; the output of the latter stage is produced at TP25.

When switch SB(1-3) is set to 'A.C.', signals applied to the input terminals (TP1 & TP2) pass via the A.C. Sensitivity control RV13 and the circuit of VT1 and VT2. When the switch is set to 'Test', 100 c/s signals from TPC60 'a' (terminal point TP6) pass via the above circuit (i.e., VT1 & VT2). For both switch-settings, signals produced at TP25 are fed to terminal point TP28.

For the 'D.C.' setting of the switch, signals applied to the input terminals pass via R3-C3 and are hence fed directly to TP28; the a.c.-input circuit of VT1 and VT2 is therefore not employed.

For all three switch-settings, signals presented to TP28 pass via the d.c.-coupled amplifier/inverter VT3 which feeds the Schmitt trigger circuit of VT5 and VT6.

Rectangular pulses at either the input or the test frequency are produced at the output of the Schmitt circuit, i.e. at TP19. These signals are selected by the rotor of Function Selector wafer SA2 on Frequency function, but by wafer SA1 on Period function.

6.7 GATING CIRCUIT

This circuit (E66/15) housed by TPC67 has two input lines, a START line connected to terminal point TP15 and a STOP line connected to TP14.

The gate control circuit comprises transistors VT7-10 which are arranged to function as two interlocked binaries. The first or START binary comprises VT7 and VT8; the second or STOP binary comprises VT9 and VT10.

Prior to gating action, a reset signal (applied to the junction of R23 and R30) sets the binaries to the condition in which the START binary is responsive only to a positive-going signal at the base of VT7, whilst the STOP binary is responsive only to a positive-going signal at the base of VT9.

With the binaries in this reset condition, the first positive-going 'start' signal supplied to TP15 passes via C11 and triggers the START binary. The collector potential of VT8 swings positive and the STOP binary is triggered by the resultant positive pulse passed via C14 to the base of VT9; VT10 collector potential swings from approximately -8V to approximately -2V as the STOP binary is triggered.

In this new condition, the START binary is no longer responsive to signals via C11, and the STOP binary is responsive only to a positive-going signal via TP14. The next positive-going signal ('stop' signal) supplied to TP14 passes via C17 and triggers the STOP binary back to its original condition; the collector potential of VT10 consequently swings back to approximately -8V, having remained at the more positive potential (approx.-2V) for a duration equal to the gating time (i.e., the interval between the 'start' and 'stop' signals).

With the Gate Control switch SD(1 & 2) set to select external gate control, the input point TP15 is subject to 'start' signals supplied to socket SKT'A' whilst TP14 is subject to 'stop' signals supplied to SKT'B'. With the switch set to select internal gate control terminal points TP14 and TP15 are linked together; single line control is then employed, the 'start' and 'stop' signals being consecutive positive-going signals supplied from the rotor of Function Selector wafer SA4.

Within the stage TPC67 transistors VT11 and VT12 form a common emitter gate. The collector potential of VT10(available at terminal point TP10) feeds the base of VT11 and serves as the control input for the gate. Signals supplied to terminal point TP7 are applied

to the base of VT12; corresponding signals are produced at the output of the gate (TP9) whenever the control input is at the more positive potential (VT10 collector approx. -2V).

Signals fed to the gate via TP7 are supplied by the Function Selector wafer SA2. Signals passed through the gate to TP9, are fed to the Counter Chain.

6.8 COUNTER CHAIN & INDICATORS

From TP9 of stage TPC67, gated signals are fed to the counter chain which comprises six cascade-connected decade circuits; each decade serves as a counter stage.

The first two decades of the chain are housed by TPC61/1. In the circuit of this stage (E32/98) transistors VT9-19 form the first or H.F. decade, which is fed via TP39, and VT1-8 form the second decade. The output of the first stage is coupled to the input of the second by capacitor C1. The respective decades operate in a similar manner to those of TPC61 (refer Section 6.4), but in addition 'staircase' current outputs representative of the respective count conditions of the stages are provided; at TP40 (1st decade) and TP1 (2nd decade).

The output of the second decade, produced at TP3, is fed to terminal point TP33 of stage TPC60/1'a' (E32/84). This is the first of two identical stages which are cascade-connected and respectively house the 3rd & 4th, and 5th & 6th decades of the chain. These decades operate in a similar manner to those of stage TPC60 (refer Section 6.4) but 'staircase' current outputs are provided at TP32 and TP6.

Each of the six cascade-connected decades constituting the chain serves as a scale-of-ten counter and produces one positive-going output pulse for every ten pulses received at its input. Six indicators M1-6, individually driven by the 'staircase' outputs of the decades, display the count. Potentiometers RV1-12 are the Set Zero (odd numbered) and Set Mine (even numbered) controls provided for adjusting the displays of the indicators.

6.9 OPERATION FOR FREQUENCY FUNCTION

With switch SD(1&2) set for internal gate control, the circuit functions as follows.

The rotor of switch-wafer SA1 feeds the 10 c/s signals from TP5 of stage TPC60'a' to the input of the second frequency divider

TPC60'b'. As a result, signals of frequency 0.1 c/s and 1 c/s are available at stators 2 and 3, respectively, of wafer SA4; 10 c/s signals from TP5 of stage TPC60'a' are available at stator 4.

One of these frequencies (0.1, 1, 10 c/s) is selected by the rotor of SA4 to control the gating circuit, via TP14 and TP15, of stage TPC67. Thus the gate is opened for 10 seconds (switch position 2), 1 second (position 3) or 0.1 second (position 4) according to the setting of the Function Selector SA.

Signals at the input frequency (applied at TP1) or at the 100 c/s test frequency (obtained from TP6 of TPC60'a'), depending upon the setting of switch SB, are produced at TP19 of stage TPC67; refer Section 6.6. The signals are fed via switch-wafer SA2 (any position 2-4) to the input of the gate; TP7 of stage TPC67. The signals are gated for the pre-selected time (set by SA4) and are hence passed to the counter chain via TP9 of the gating stage.

6.10 OPERATION FOR PERIOD FUNCTION

With switch SD (1&2) set for internal gate control, the circuit functions as follows.

Signals at the input frequency (or at the test frequency if SB is set to 'Test') are produced at TP19 of stage TPC67; they are hence fed via switch-wafer SA1 to the input of the second frequency divider TPC60'b'.

Signals at this frequency or at one-tenth or one-hundredth of this frequency (available at TP33, 6 and 5 respectively of the second divider) are selected in accordance with the setting of the Period Cycles slide-switch SKT(1-3) and are fed to switch-wafer SA4 stators 5-10: the signals are applied to TP14 & TP15 of stage TPC67 and serve to control the gate.

During the gating time (i.e., selected signal 'period') signals at one of six frequencies, produced by the first frequency divider and selected by switch-wafer SA2, pass via the gate (TPC67; TP7 & TP9) to the counter chain.

The SA2-stator/frequency relationship is as follows.

Stator	5	: 10 c/s
"	6	: 100 "
"	7	: 1 kc/s
"	8	: 10 "
"	9	: 100 "
"	10	: 1 Mc/s

6.11 STANDARD FREQUENCY OUTPUT

This output is selected, by the rotor of switch-wafer SA3, from eight signal frequencies obtained from the first and second frequency dividers. Signals at the selected frequency are fed to socket SKT'F'. The switch-setting/Std. Frequency output relationship is listed in Section 2.11.

6.12 DISPLAY TIMING & RESET ZERO CIRCUIT

This circuit (E66/15) incorporates VT13 and VT14, which form a monostable multivibrator, and VT15 & VT16 which operate as inverters. With the RESET switch SE (1&2) set to 'Auto', operation is as follows.

Diode MR4 (connected to VT7 collector) normally conducts to hold the multivibrator inoperative. As a 'start' signal is received and the collector potential of VT7 swings negative (refer Section 6.7) diode MR4 becomes reverse-biased and the operation of the multivibrator circuit is subject to signals, passed via R37, from the collector of VT10 (2nd transistor of STOP binary).

The collector potential of VT10 swings negative at the conclusion of the gating period. This signal is applied (via R37) to the base of VT13 so that the transistor is triggered to the conductive state; cut-off of VT14 collector current results.

The multivibrator remains in this condition for the pre-set display time (approx. 1-5 seconds) which is dependent upon the time constant of the circuit formed by C20 and the series-parallel connected resistances R19, R4 and RV14.

As C20 discharges (so that the base potential of VT14 becomes negative with respect to the emitter) transistor VT14 conducts and the circuit reverts to the original or stable state (i.e., VT13 non-conductive; VT14 conductive). A positive-going signal is therefore produced at the collector of VT14 and a pulse is applied to inverters VT15 and VT16. The resultant negative-going signal produced at VT16 collector (and at TP1) constitutes a Reset Zero pulse.

When the multivibrator reverts to the stable state, the charge held by C19* ensures that the circuit cannot be triggered again for approximately 800mS and thereby allows time for capacitor C20 to

---

* Time constant : approx. C19 x R37

fully charge. Thus, in the event of a very short gating period occurring immediately after reset action, the charge of C19 delays triggering of the multivibrator and so avoids a reduced display time which might otherwise occur if C20 were insufficently charged.

With the RESET switch SE (1&2) set to 'Manual', the base of VT14 (linked to TP5) is connected via R18 to chassis-earth and thus the multivibrator is held inoperative.

The collector of VT14 is connected via TP6 to the RESET IN socket SKTD.

A Reset input signal*, or momentary depression of the push button SG, gives rise to a positive-going signal at the collector of VT14 and to a negative-going pulse at TP1 and at the collector of VT15.

The latter pulse is fed, via R23 and R30, to the gate-control binaries and resets them to the zero condition. The pulse produced at TP1 is applied to the main reset zero line (connected to terminal points of various stages as indicated on the main circuit diagram) so that the decades of the counter chain and both frequency divider chains are reset to the zero condition in readiness for a further measurement. The Reset Zero pulse is also fed to the RESET OUT socket SKTE.

6.13 RESET NINE CIRCUIT

Resistor R75 of stage TPC61/1, capacitor C6, and the normally closed push button SH (which links the junction of R75 and C6 with the chassis-earth line) form the Reset Nine circuit. When the push button is pressed, the potential of the reset-nine line swings negative from chassis-earth potential. The change in level is applied (via TP36 of TPC61/1, and TP1 of each TPC60/1 stage) to the six decades of the counter chain and sets them to the 9-condition; a display of '999999' is therefore presented by the indicators.

This facility is used in checking the indicator displays; refer Section 4.3.

6.14 BLANKING CIRCUIT

The indicator lamp supply (approx. 12V D.C.) is provided between chassis-earth (+ve) and the Y connection (-ve) of rectifier MR3.

---

* Refer Section 2.8

This supply feeds the parallel connected lamps either:-

(i) Via the Blanking switch SJ when it is set to the OFF position (In this case the lamps are illuminated while the instrument is switched ON).

or (ii) Via Blanking Circuit (E66/9) transistors VT5 & VT6 when switch SJ is set to ON and the transistors are in the conductive state. (With this switch-setting the lamp current is cut-off for the entire gating period).

The parallel-connected transistors VT5 and VT6 are controlled by the circuit incorporating VT1 & VT2 (arranged as a binary) and emitter followers VT3 & VT4. This circuit is operated by the gate-control-potential (refer Section 6.7) which is applied via TP2 to R1 and C1.

The gate-control-potential may be at either of two levels; approx. -8V (gate closed) or approx. -2V (gate open).

While the control potential is at the more negative level (approx. -8V), collector current flows via VT1; as a result, VT2 is held non-conductive whilst VT3, MR3 and VT4 conduct to hold 'ON' transistors VT5 & VT6. Lamp current therefore flows to illuminate the display. When the control potential swings positive to approx. -2V,a positive-going pulse is applied, via C1 and MR2, to the base of VT1; this triggers the binary circuit to the reverse state. As VT2 conducts, current ceases to flow via the Zener diode MR3; cut-off of collector current (lamp current) in VT5 and VT6 results.

The condition of blanking (non illumination of the lamps) is maintained until, at the end of the gating period, the -8V level is restored to reverse the condition of the binary (VT1-VT2) and lamp current again flows via VT5 and VT6.

To allow time for the indicator movements to settle (as certain of these may be in the half full-scale deflection position, if a high speed count has occurred, whilst others e.g. the M.S.D. indicator may be in motion) a delay of approximately 450mS in the reversal of the binary VT1-VT2 is introduced by the time constant C4 x R1, effective in the base circuit of VT1.

6.15 B.C.D. OUTPUT CIRCUIT

This circuit, wired only when modification 'Z' is ordered, is represented in the right hand region of diagram ES66/16. A collector of each binary circuit constituting the counter decades is connected either directly or (in the case of the high frequency decade) via resistors of B.C.D. Buffer stage TPC17 to output socket SKT'J'. The B.C.D. output is produced in the code 1-2-4-2'.

The gate-control-signal (refer Section 6.7) is applied to TP3 of stage TPC17 (E66/18) and hence passes via VT1 and TP8 to SKTJ pin 33. A negative-going Print/Punch Command signal is produced at this output connection upon closure of the gate. The Reset IN line is connected to SKTJ pin 31 and facilitates the initiation of reset action by signals from external data logging equipment.

Signals produced at the B.C.D. output socket are specified in Section 2.10.

7. CIRCUIT REFERENCES

7.1 CIRCUIT ES66/16 (MAIN CIRCUIT) REFERENCE

Resistors		
R1	47kΩ	
R2, (20-24)	Not Used	
R3	10kΩ	
R4	820kΩ	
R5,7,9,11,13,15	4.7kΩ	
R6,8,10,12,14	6.8kΩ	
R16	2.2kΩ	
R17,18	3.3kΩ	
R19	18kΩ	
R25	1kΩ	
Resistors Variable		
RV1,3,5,7,9,11	1kΩ	(Set Zero controls)
RV2	20kΩ	(Set Nine control)
RV4,6,8,10,12	10kΩ	(Set Nine controls)
RV13	500kΩ	(A.C. Sensitivity control)
RV14	500kΩ	(Display Time control)
Capacitors		
C1,11	Not Used	
C2	60pF	
C3	120pF	
C4	0.22µF	
C5	220pF	
C6	4µF	
C7 (a-c)	0.1+0.005+0.005µF	(mains suppressor)
C8	1125µF	
C9	0.04µF	
C10	8µF	
C12	200µF	
Rectifiers		
MR1	Not Used	
MR2,3	M200	
Transistor		
VT1	OC25	
Fuse		
FS1	0.5A	(H.T. fuse; 3/16"D x 5/8"cartridge)

Meter Indicators	
M (1-5)	250µA F.S.D. E.A.C. MkII Digivisors
M6	166µA F.S.D. E.A.C. MkII Digivisor
Transformer	
T1	Albion type WO276
	Pri: 0-102-112-122-205-225-245V
	Sec: 14V, 1.8A
Crystal	
XL1	Marconi type QO 167CL (1 Mc/s)
Crystal Oven	
Oven	Cathodeon type MCO-2M
Terminal/sockets	
TP1	Signal Input (high)
TP2	Signal Input (earthy)
Sockets	
SKT A	External Gating START Input
SKT B	" " STOP "
SKT C	Earth
SKT D	External Reset IN
SKT E	Reset OUT
SKT F	Standard Frequency Output
SKT G	Battery Input Connector (McMurdo type TRS1)
SKT H	External Crystal Reference Input
SKT J	B.C.D. Output
Switches	
SA (1-5)	Function Selector
	Position 1 : Mains supply OFF
	" 2 : Frequency c/s X0.1
	" 3 : " " X1
	" 4 : " " X10
	" 5 : Period mS X100
	" 6 : " " X10
	" 7 : " " X1
	" 8 : " µS X100
	" 9 : " " X10
	" 10 : " " X1

SB (1-3)	D.C./Test/A.C. Selector
	Position 1 : D.C.
	" 2 : Test
	" 3 : A.C.
SC1	Crystal Reference Selector
	Position 1 : Internal
	" 2 : External
SD (1&2)	Internal/External Gating Selector
	Position 1 : Internal
	" 2 : External
SE (1&2)	Manual/Auto. Resetting Selector
	Position 1 : Auto.
	" 2 : Manual
SF (1&2)	Battery/Mains Supply-selector
	Position 1 : Battery
	" 2 : Mains
SG	Reset 0 Push button
SH	Reset 9 Push button
SJ	Blanking ON/OFF switch
SK (1-3)	Period Cycles Selector
	Position 1 : X1
	" 2 : X10
	" 3 : X100

7.2 CIRCUIT E32/77 (TPC60) REFERENCE

Resistors

R1,4,6,10,13,15,18,21,23,26, 29,31,35,38,40,43,46,48,51, 54,56,59,62,64	10kΩ
R2,11,19,27,36,44,52,60	Not Used
R3,8,12,17,20,25,28,33,37 42,45,50,53,58,61,66	2.2kΩ
R5,7,30,32,39,41,63,65	8.2kΩ
R9,34	27kΩ
R14,16,22,24,47,49,55,57	6.8kΩ
R67	68Ω

Capacitors

C1,4,7,8,10,14,17,20,21,23	220pF
C2,3,5,6,11,15,16,18,19,24	300pF
C9,13,22,26	390pF
C12,25	1000pF

Diodes

MR (1-20)	OA91

Transistors

VT (1-16)	OC45

7.3 CIRCUIT E32/78 (TPC61) REFERENCE

Resistors	
R1,4,6,10,13,15,18,21,23,26, 29,31,47,50,56,59,65,68	10kΩ
R2,11,19,27,42	Not Used
R3,8,12,17,20,25,28,33,46,51, 55,60,64,69,70,72	2.2kΩ
R5,7,30,32	8.2kΩ
R9	27kΩ
R14,16,22,24	6.8kΩ
R34	150Ω
R35	160kΩ
R36,42,75	1.5kΩ
R37,38,40,41	15kΩ
R39	240Ω
R43,61	72kΩ
R44,45,53,54,62,63	5.6kΩ
R48,49,57,58,66,67	7.5kΩ
R52	36kΩ
R71	1kΩ
R73,74	3.3kΩ
Capacitors	
C1,4,7,8,10	220pF
C2,3,5,6,11	300pF
C9,13	390pF
C12	1000pF
C(14-17),19,20,24,25,29,30	120pF
C18	0.04μF
C21,22,26,27,31,32	150pF
C23,28	100pF
C33	270pF
Diodes	
MR (1-28)	OA91
Transistors	
VT (1-8),18	OC45
VT (9-17),19	OC44

7.4 CIRCUIT E32/84 (TPC60/1) REFERENCE

Resistors	
R1,4,6,10,13,15,18,21,23,26, 29,31,35,38,40,43,46,48,51 54,56,59,62,64	10kΩ
R2,36	72kΩ
R3,8,12,17,20,25,28,33,37,42, 45,50,53,58,61,66	2.2kΩ
R5,7,30,32,39,41,63,65	8.2kΩ
R9,34	27kΩ
R11,44	36kΩ
R14,16,22,24,47,49,55,57	6.8kΩ
R19,52	17.6kΩ
R27,60	34.75kΩ
R67	68Ω
Capacitors	
C1,4,7,8,10,14,17,20,21,23	220pF
C2,3,5,6,11,15,16,18,19,24	300pF
C9,13,22,26	390pF
C12,25	1000pF
Diodes	
MR (1-20)	OA91
Transistors	
VT (1-16)	OC45

7.5 CIRCUIT E32/98 (TPC61/1) REFERENCE

Resistors	
R1,4,6,10,13,15,18,21,23,26, 29,31,47,50,56,59,65,68	10kΩ
R2,43,61	72kΩ
R3,8,12,17,20,25,28,33,46,51, 55,60,64,69,70,72	2.2kΩ
R5,7,30,32	8.2kΩ
R9	27kΩ
R11,52	36kΩ
R14,16,22,24	6.8kΩ
R19	17.6kΩ
R27	34.75kΩ
R34	150Ω
R35	160kΩ
R36,42,75	1.5kΩ
R37,38,40,41	15kΩ
R39	240Ω
R44,45,53,54,62,63	5.6kΩ
R48,49,57,58,66,67	7.5kΩ
R71	1kΩ
R73,74	3.3kΩ
Capacitors	
C1,4,7,8,10	220pF
C2,3,5,6,11	300pF
C9,13	390pF
C12	1000pF
C14,15,16,17,19,20,24,25,29,30	120pF
C18	0.04μF
C21,22,26,27,31,32	150pF
C23,28	100pF
C33	270pF
Diodes	
MR (1-28)	OA91
Transistors	
VT (1-8),18	OC45
VT (9-17), 19	OC44

7.6 CIRCUIT E32/99 (TPC62/1) REFERENCE

Resistors	
R1,2	68kΩ
R3	220Ω
R4,5	3.3kΩ
R6	1kΩ
R7,8,10,12	5.6kΩ
R9	470Ω
R11	100Ω
R13	270Ω
R14	Not Used
R15,17,22,24,29,31,36,38,43	2.2kΩ
R16,18,20,23,25,27,30,32,34, 37,39,41	10kΩ
R19,21,40,42	8.2kΩ
R26,28,33,35	6.8kΩ
R44	27kΩ
R45	150Ω
Capacitors	
C1	4-60pF (trimmer)
C2,8,11,14,15,17	220pF
C3	150pF
C(4-7),18	1000pF
C9,10,12,13,20	300pF
C16,19	390pF
Diodes	
MR (1-10)	OA91
Transistors	
VT (1-4)	OC44
VT (5-12)	OC45

7.7 CIRCUIT E66/15 (TRC67) REFERENCE

Resistors	
R1	68kΩ (1W)
R2,4,12,13,14,34,36,49,52	Not Used
R3	220kΩ
R5,45	2.2kΩ
R6	39kΩ
R7	150kΩ
R8,11,43	1kΩ
R9,(22-25),(29-32)	15kΩ
R10,19,27	270Ω
R15,54	470Ω
R16,18,51,53	5.6kΩ
R17	68Ω
R20	10kΩ
R21,26,28,33,35	1.5kΩ
R37,41	100kΩ
R38,40	4.7kΩ
R39,46	3.3kΩ
R42	8.2kΩ
R44	1.8kΩ
R47	82kΩ
R48,50	100Ω
Capacitors	
C1	60pF
C2,8	Not Used
C3,20	30μF
C4	390pF
C5,7,19	8μF
C6	100μF
C9,18	1000pF
C10,11,17	150pF
C(12-16)	120pF
C21	4μF
C22,25	0.04μF
C23	0.01μF
C24	0.005μF

Diodes	
MR1,2,3,5,6,7	OA91
MR4,8	OA202
Transistors	
VT1,15,16	CC42
VT2,3,(5-12)	CC44
VT4	Not Used
VT13,14	CC45

7.8 CIRCUIT E66/9 (TPC34) REFERENCE

Resistors	
R1,9,11	33kΩ
R2,3,12	4.7kΩ
R4	220Ω
R5	10kΩ
R6,7	22kΩ
R8	27kΩ
R10	820Ω
R13	2.2kΩ
R14,17	47Ω
R15,16	150Ω
Capacitors	
C1	220pF
C2,3	560pF
C4	16µF
C5	30µF
Diodes	
MR1	OA202
MR2	OA91
MR3	Z2A33F
Transistors	
VT1,2,3	OC45
VT4	BCZ11
VT5,6	OC83

7.9 CIRCUIT E66/17 (TPC20) REFERENCE

Resistors	
R1	1.5kΩ
R2	2.2kΩ
R(3-5)	1kΩ
R6	4.7kΩ
R7	680Ω
Resistor Variable	
RV1	5kΩ
Capacitors	
C1	16µF
C2,3	30µF
Diode	
MR1	SX56
Transistors	
VT1,2	OC71

Note: In some instruments type TSA3436/2 the power supply group boards are not of printed circuit construction. For the non-printed circuit boards certain resistor and capacitor values differ from those listed above, viz:-

R12	560Ω
C1,2,3	100µF

7.10 CIRCUIT E66/18 (TPC17) REFERENCE

Resistors	
R1	330Ω
R2	1kΩ
R (3-6)	4.7kΩ
Transistor	
VT1	OC44

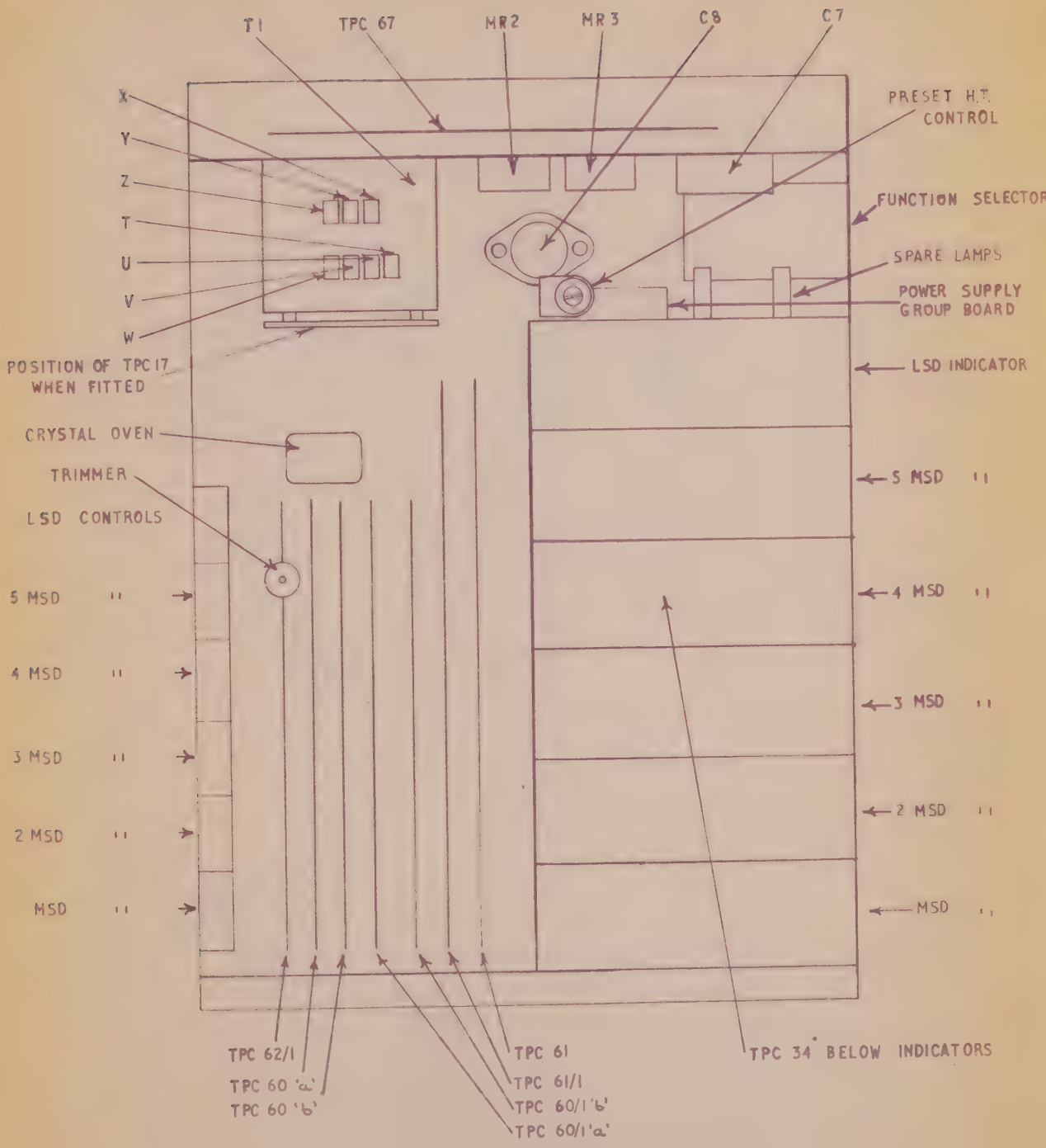
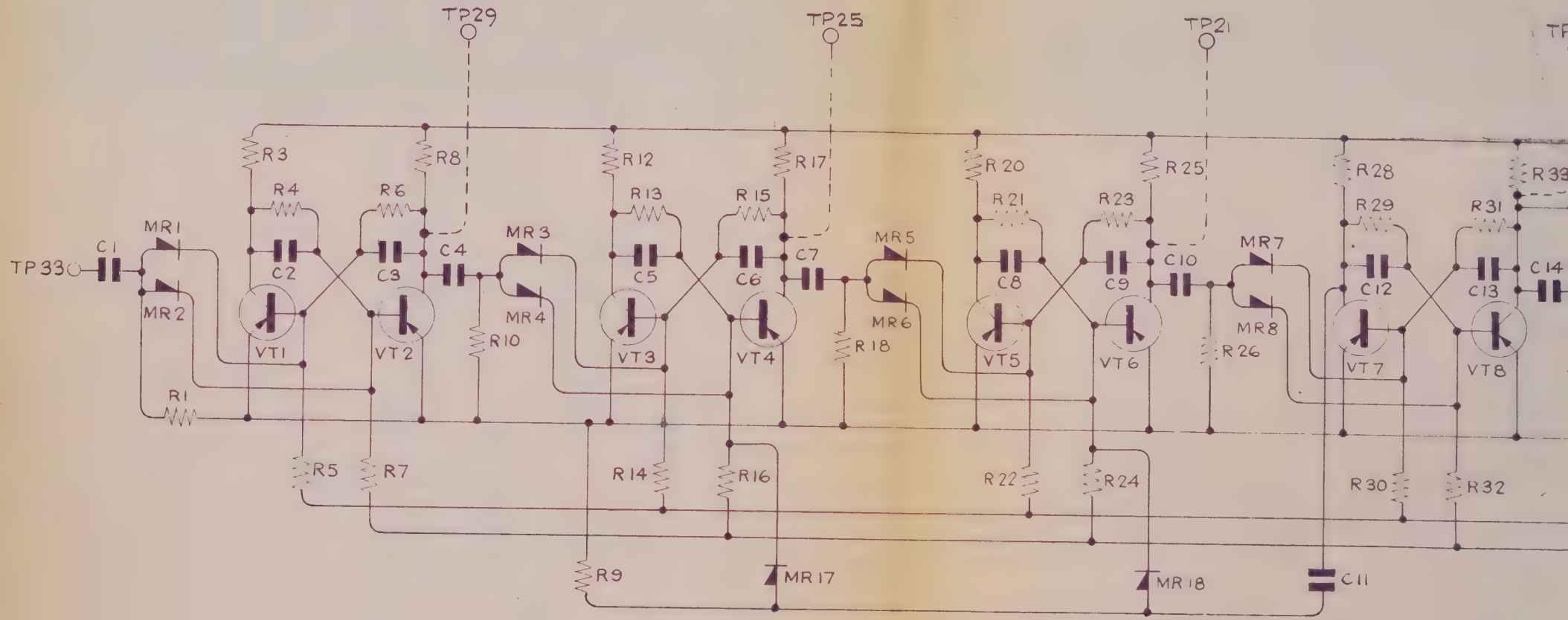
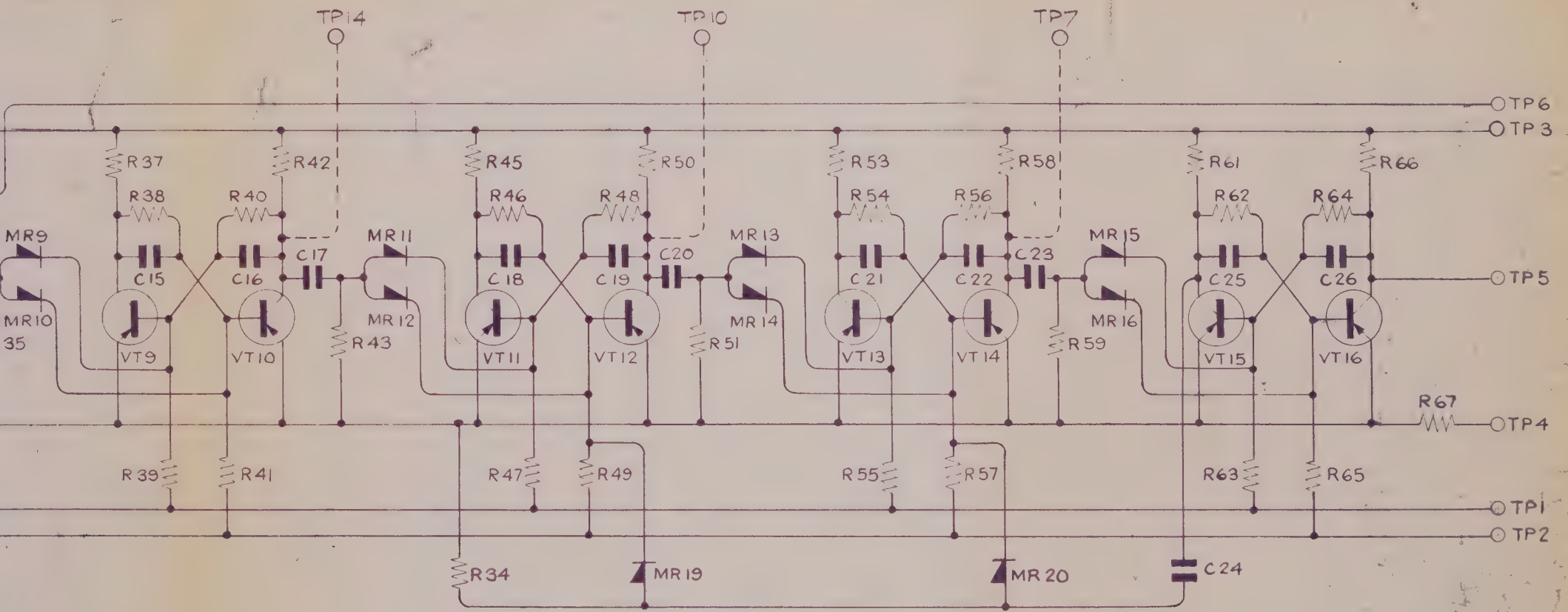


FIGURE 1. LAYOUT OF TSA 3436/2 SHOWING MAIN COMPONENTS

CIRCUIT REFERENCES RELATIVE TO DIAGRAM E S 66/16

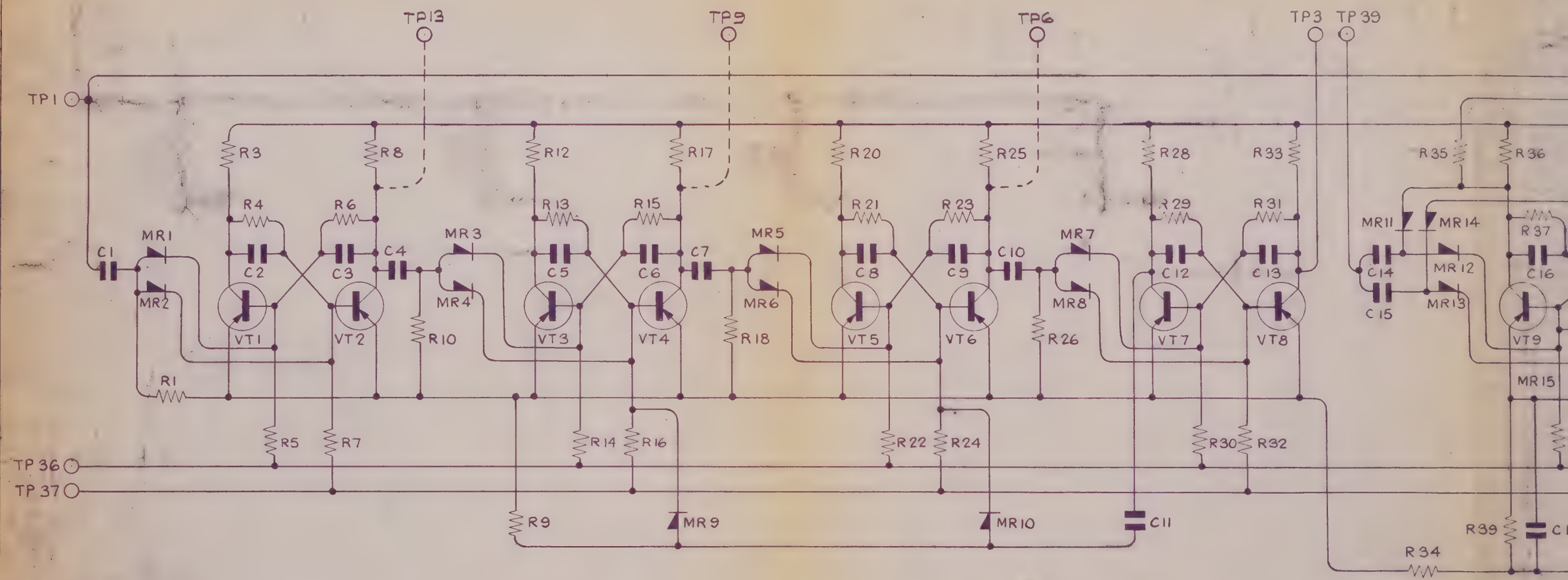

TP29
TP25
TP21
TP33
C1
MR1
MR2
R1
R3
R4
C2
VT1
R5
R7
R8
R6
C3
VT2
C4
MR3
MR4
R10
R12
R13
C5
VT3
R14
R16
R15
C6
VT4
C7
R17
R9
MR17
MR5
MR6
R18
R20
R21
C8
VT5
R22
R25
R23
C9
VT6
R24
C10
MR7
MR8
R26
MR18
R28
R29
C12
VT7
R30
C11
R31
C13
VT8
R32
C14
R33

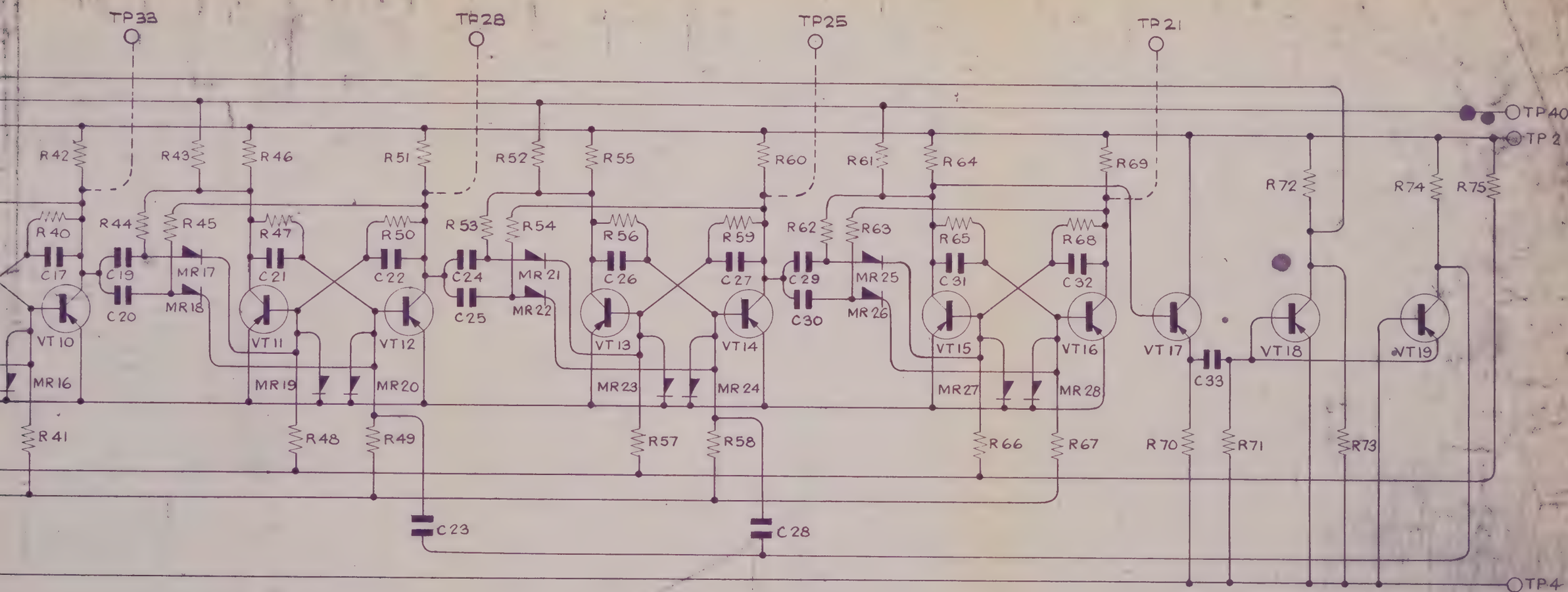


NOTE CONNECTIONS SHOWN DOTTED ARE FOR BCD O/P WHEN REQUIRED.

E 32/77		DOUBLE MF DECADE UNIT
DRAWN	R.T.S.	TYPE TPC 60
CHECKED		
DATE	21·12·62	

VENNER ELECTRONICS LIMITED
NEW MALDEN, SURREY.

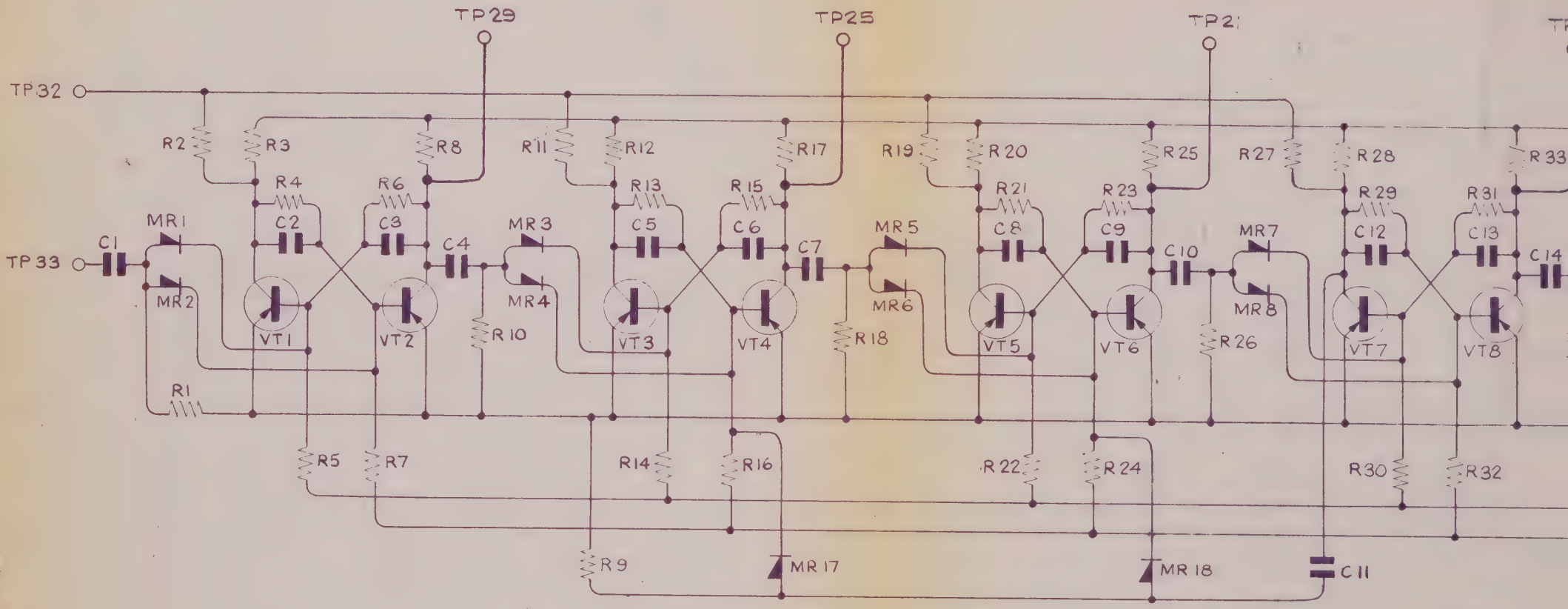

TP13
TP9
TP6
TP3
TP39
TP1
R3
R8
R12
R17
R20
R25
R28
R33
R35
R36
R4
R6
R13
R15
R21
R23
R29
R31
MR11
MR14
R37
MR1
MR3
MR5
MR7
C1
C2
C3
C4
C5
C6
C7
C8
C9
C10
C12
C13
C14
MR12
C16
MR2
MR4
MR6
MR8
C15
MR13
VT1
VT2
VT3
VT4
VT5
VT6
VT7
VT8
VT9
R10
R18
R26
R1
MR15
R5
R7
R14
R16
R22
R24
R30
R32
TP36
TP37
R9
MR9
MR10
C11
R39
R34

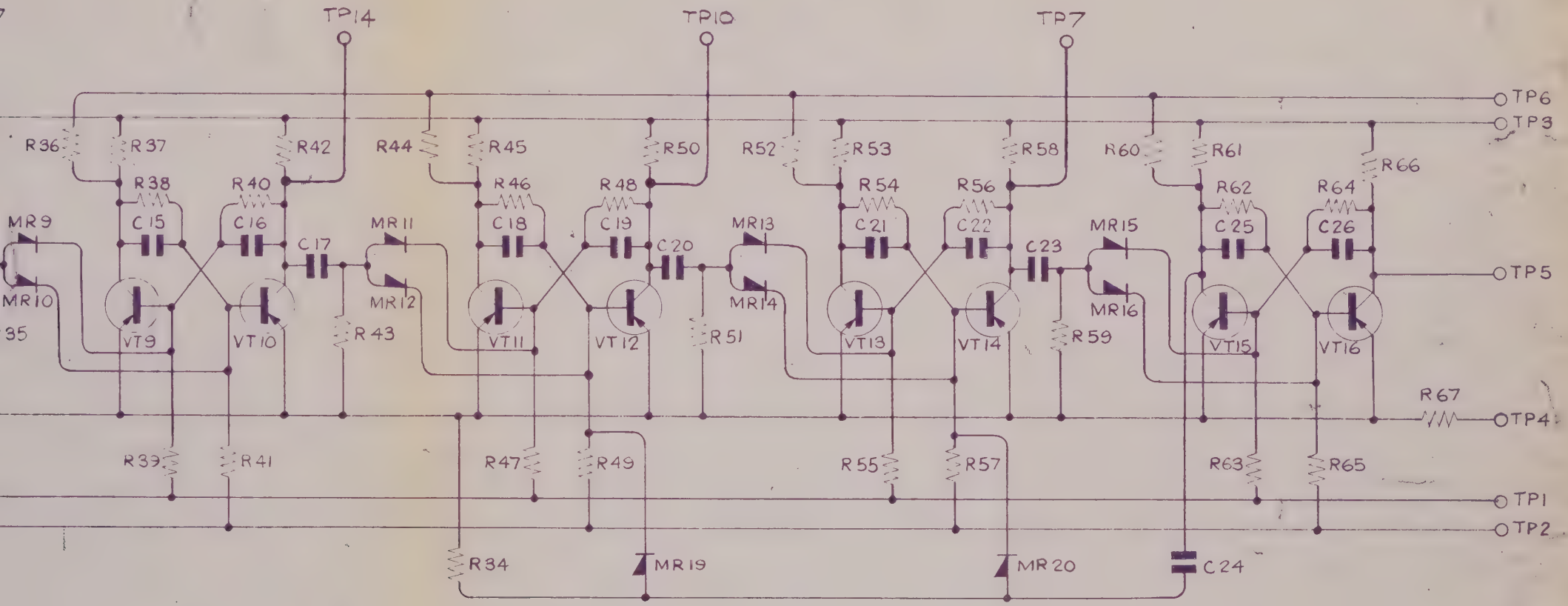


NOTE: CONNECTIONS SHOWN DOTTED ARE FOR BCD O/P WHEN REQUIRED.

E 32/78	HF/MF DECADE UNIT (DIVIDER) TYPE TPC 61
DRAWN	R.T.S.
CHECKED	
DATE	2·1·63

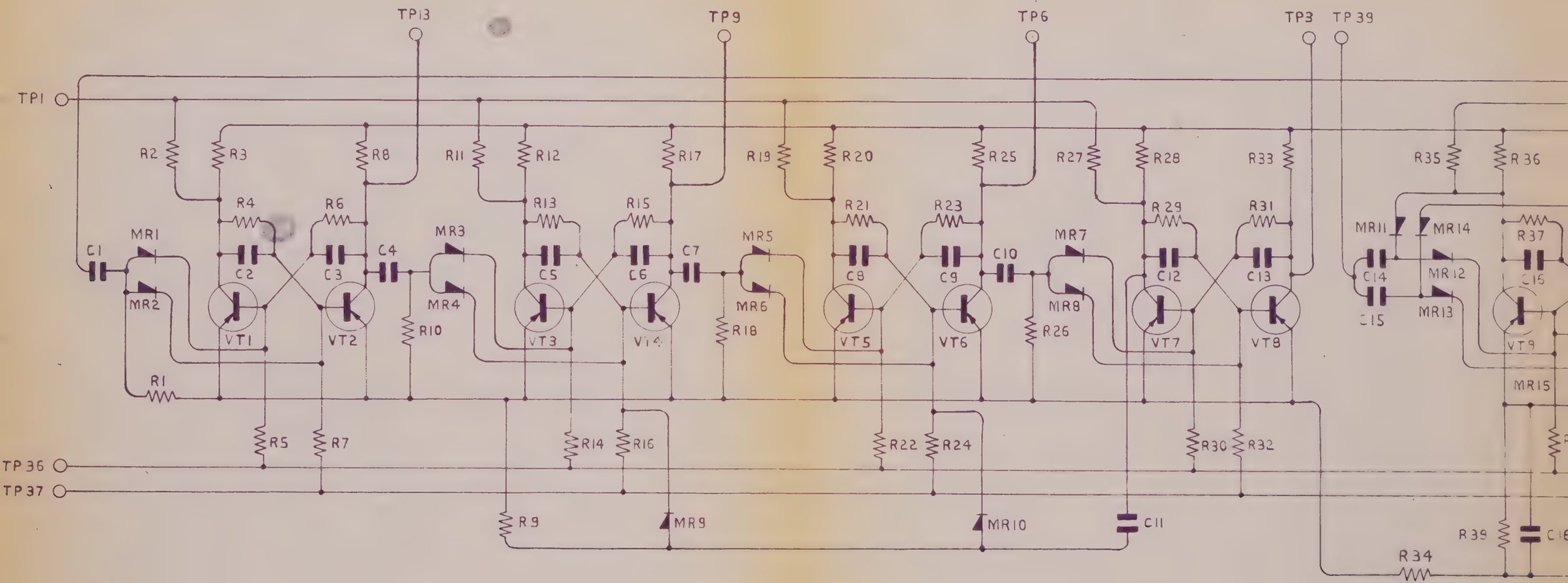
VENNER ELECTRONICS, LIMITED.
NEW MALDEN, SURREY.

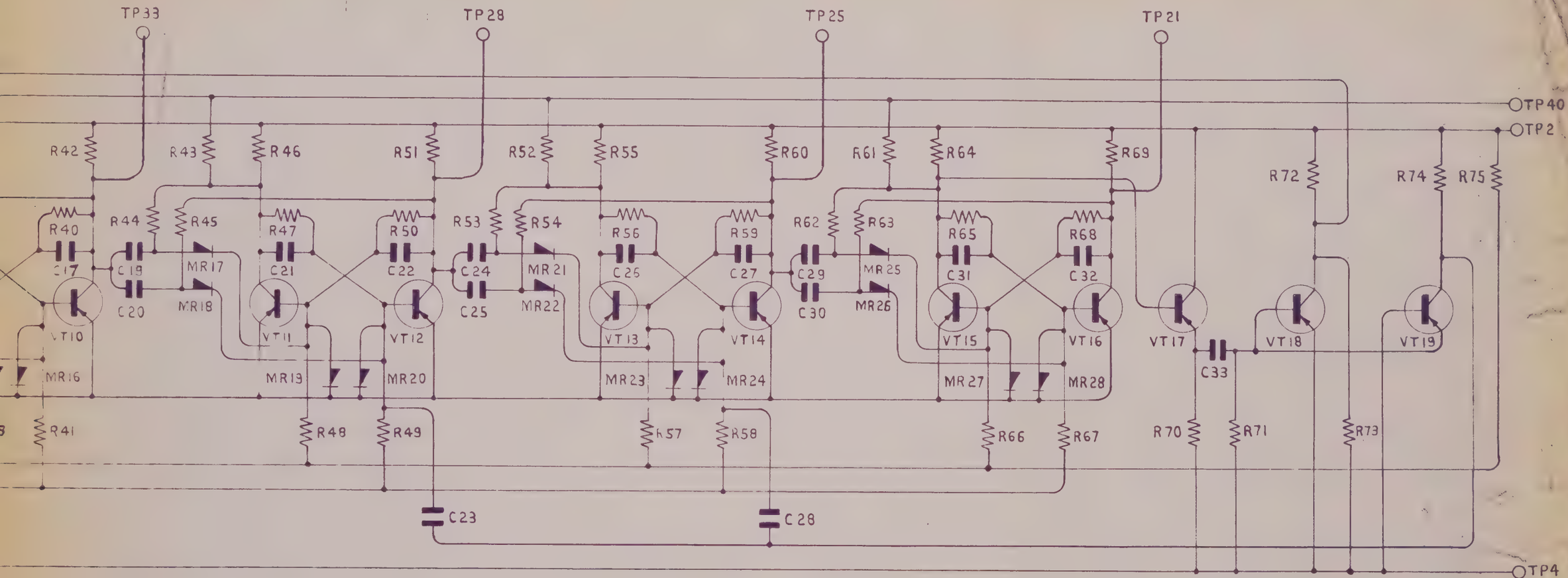

TP29
TP25
TP21
TP32
TP33
R2
R3
R8
R11
R12
R17
R19
R20
R25
R27
R28
R33
R4
R6
R13
R15
R21
R23
R29
R31
MR1
C1
C2
C3
C4
MR3
C5
C6
C7
MR5
C8
C9
C10
MR7
C12
C13
C14
MR2
MR4
MR6
MR8
VT1
VT2
VT3
VT4
VT5
VT6
VT7
VT8
R10
R18
R26
R1
R5
R7
R14
R16
R22
R24
R30
R32
R9
MR17
MR18
C11



E 32/84		DOUBLE MF DECADE UNIT
DRAWN	R.T.S.	TYPE TPC 60/1
CHECKED		
DATE	21·12·62	

VENNER ELECTRONICS LIMITED.
NEW MALDEN, SURREY.

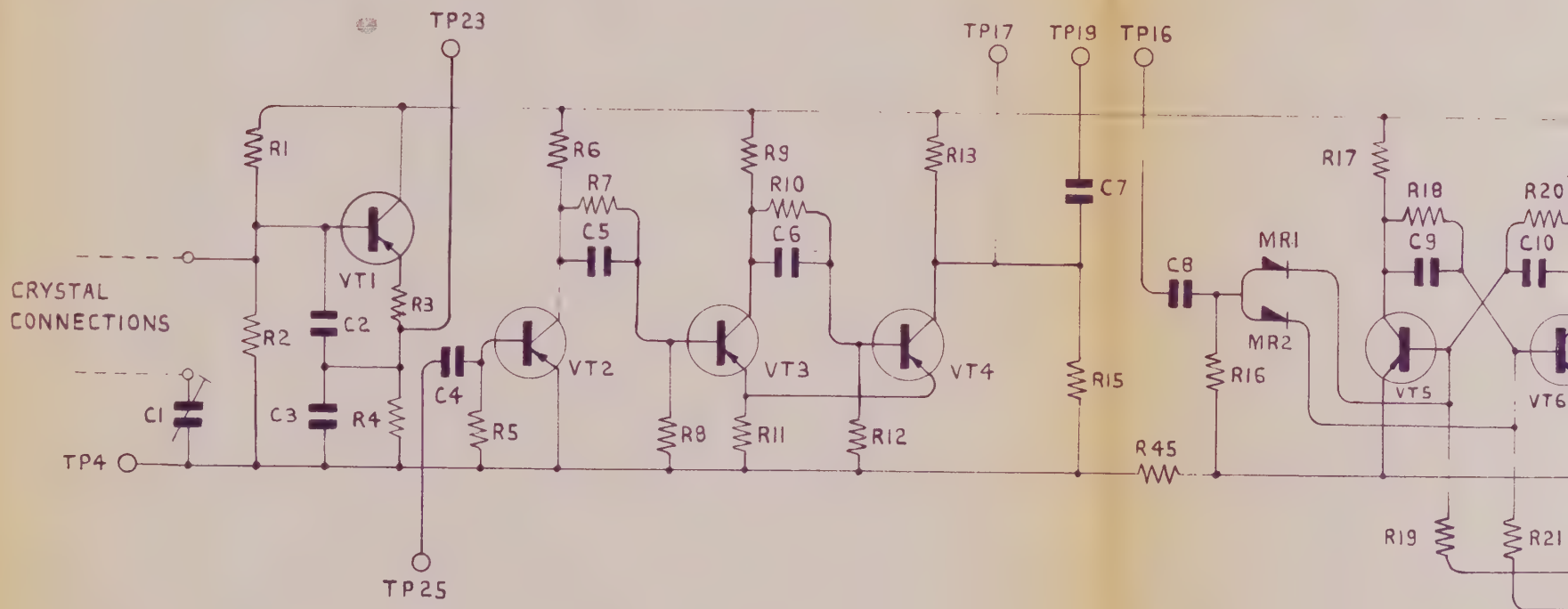

TP13
TP9
TP6
TP3
TP39
TP1
R2
R3
R8
R11
R12
R17
R19
R20
R25
R27
R28
R33
R35
R36
R4
R6
R13
R15
R21
R23
R29
R31
MR1
MR3
MR5
MR7
MR11
MR14
R37
C1
C4
C7
C10
C2
C3
C5
C6
C8
C9
C12
C13
C14
MR12
C15
MR2
MR4
MR6
MR8
MR13
VT1
VT2
VT3
VT4
VT5
VT6
VT7
VT8
VT9
R10
R18
R26
R1
MR15
R5
R7
R14
R16
R22
R24
R30
R32
TP36
TP37
R9
MR9
MR10
C11
R39
C16
R34



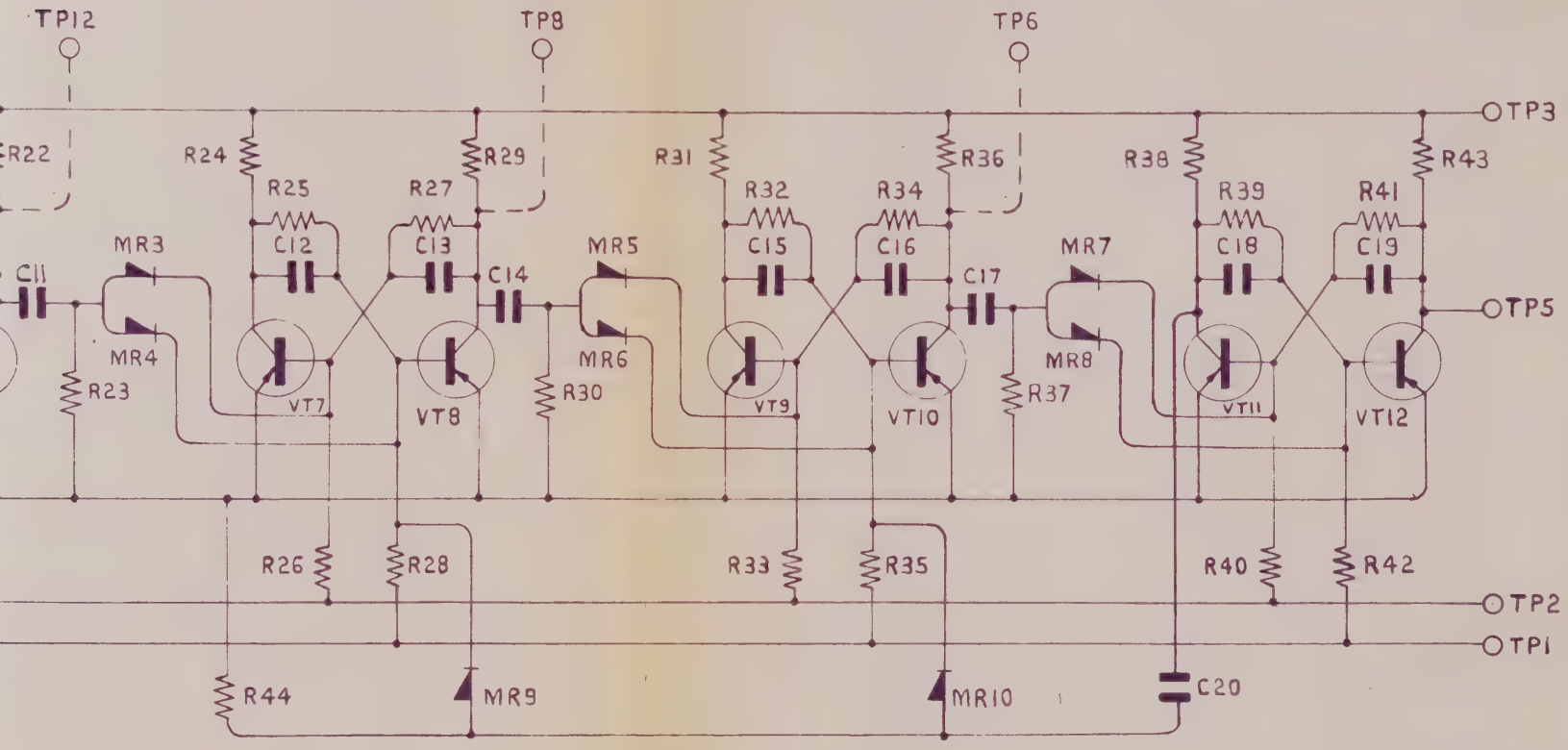
E 32/98	
DRAWN	R.T.S.
CHECKED	
DATE	18. 9. 63.

HF/MF DECADE UNIT
(COUNTER)
TYPE TPC 61/1

VENNER ELECTRONICS, LIMITED.
NEW MALDEN, SURREY.


TP23
TP17
TP19
TP16
R1
R6
R7
R9
R10
R13
C7
R17
R18
C9
R20
C10
MR1
MR2
C8
CRYSTAL
CONNECTIONS
VT1
R3
C5
C6
R2
C2
VT2
VT3
VT4
R15
R16
VT5
VT6
C1
C3
R4
C4
R5
R8
R11
R12
R45
TP4
R19
R21
TP25

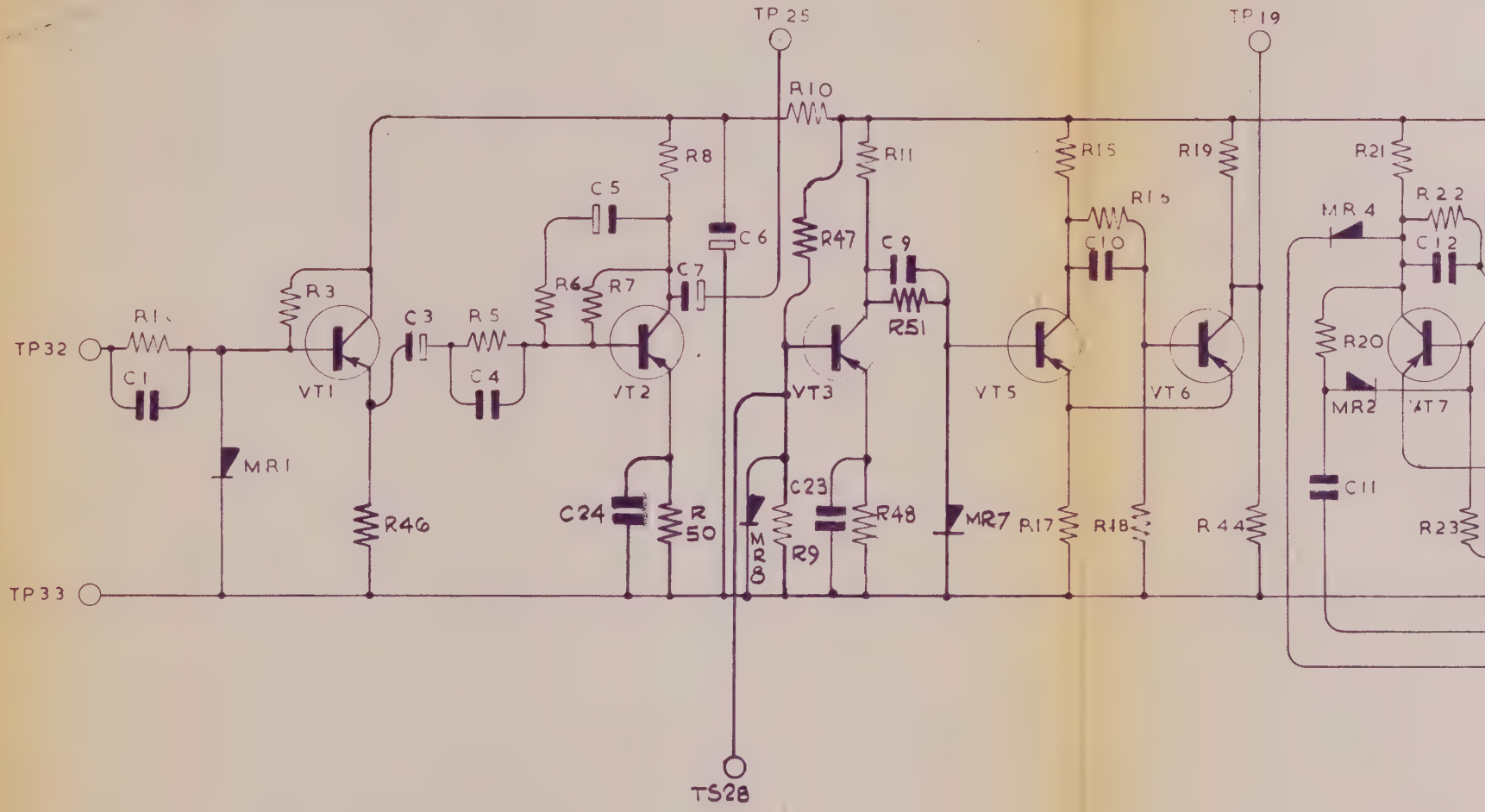
NOTE:-

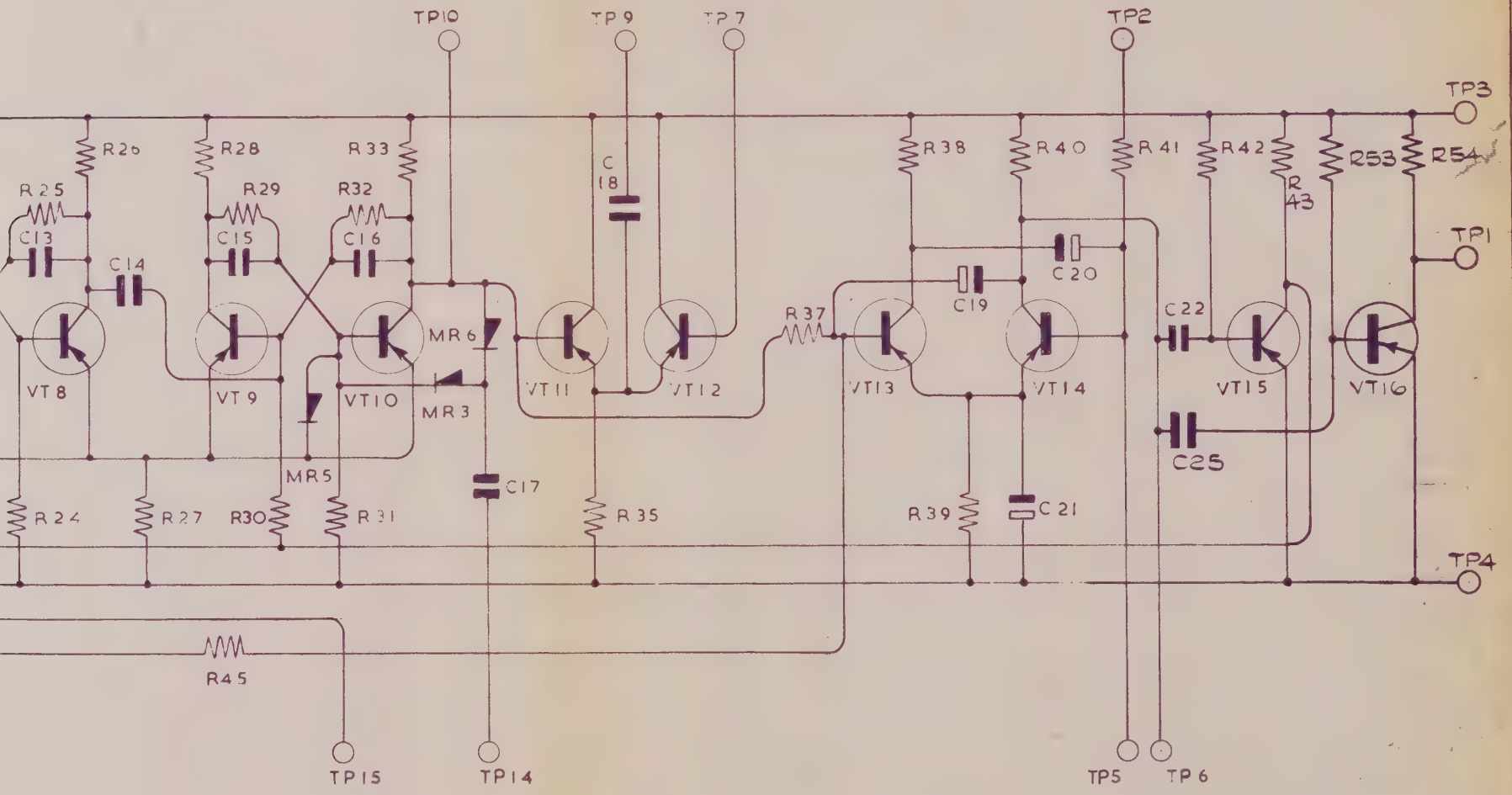


CONNECTIONS SHOWN DOTTED
ARE FOR BCD O/P WHEN REQUIRED.

E 32/99		CRYSTAL OSCILLATOR UNIT TYPE TPC 62/1
DRAWN	R.T.S.	
CHECKED		
DATE	27. 11. 63	

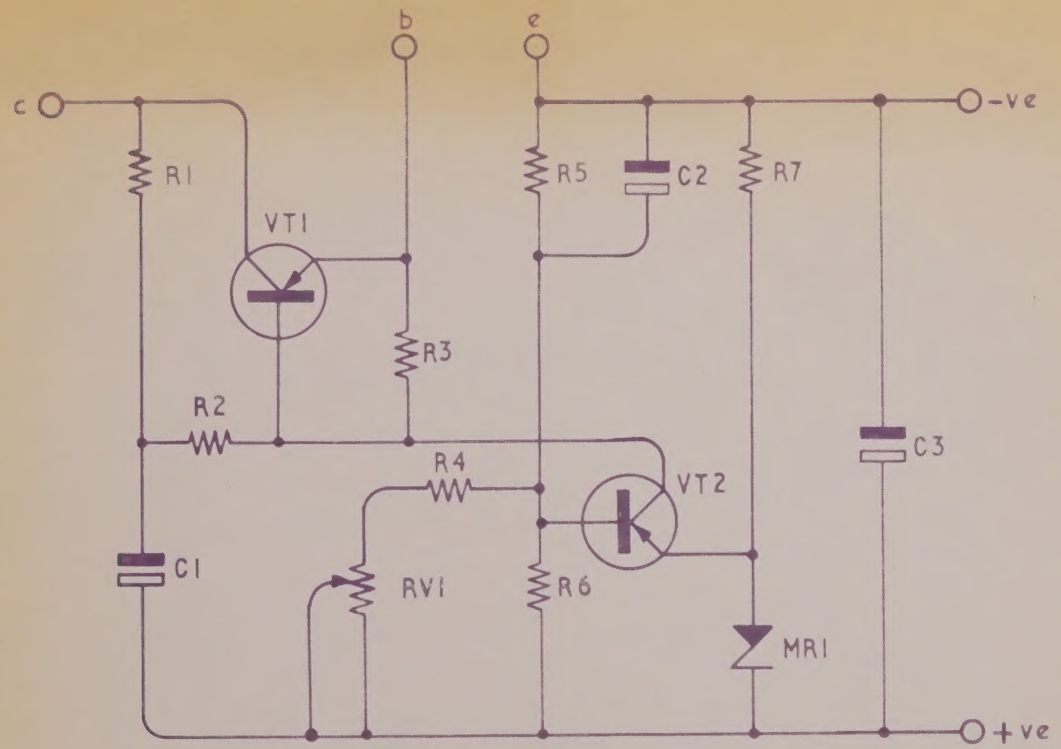
VENNER ELECTRONICS LTD
NEW MALDEN SURREY


TP25
TP19
R10
R8
R11
R15
R19
R21
C5
C6
R47
C9
R16
C10
MR4
R22
C12
R3
R6
R7
C7
R51
R20
R1
C3
R5
TP32
C1
C4
VT1
VT2
VT3
VT5
VT6
VT7
MR2
MR1
C11
C24
R50
MR8
C23
R48
MR7
R17
R18
R44
R23
R46
R9
TP33
TS28

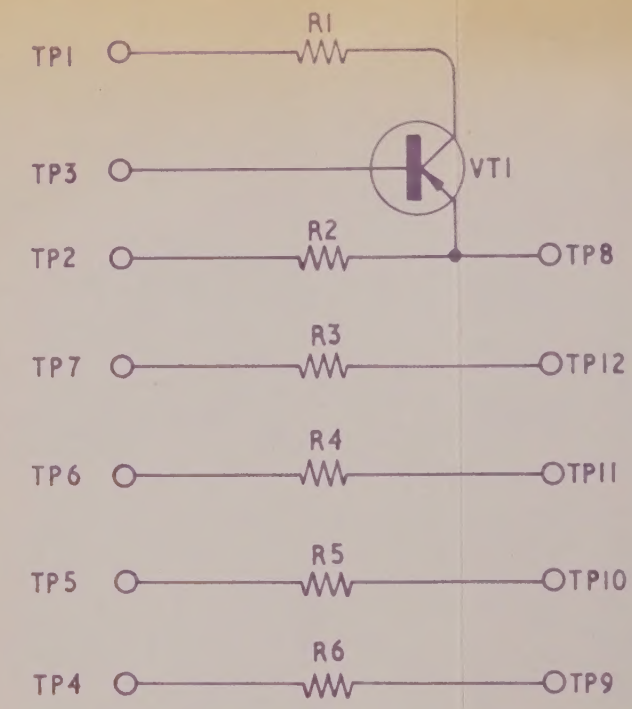


E 66/ 15	PULSE SHAPER & GATE UNIT
DRAWN	R.T. S.
CHECKED	
DATE	23-11-64
TPC 67	

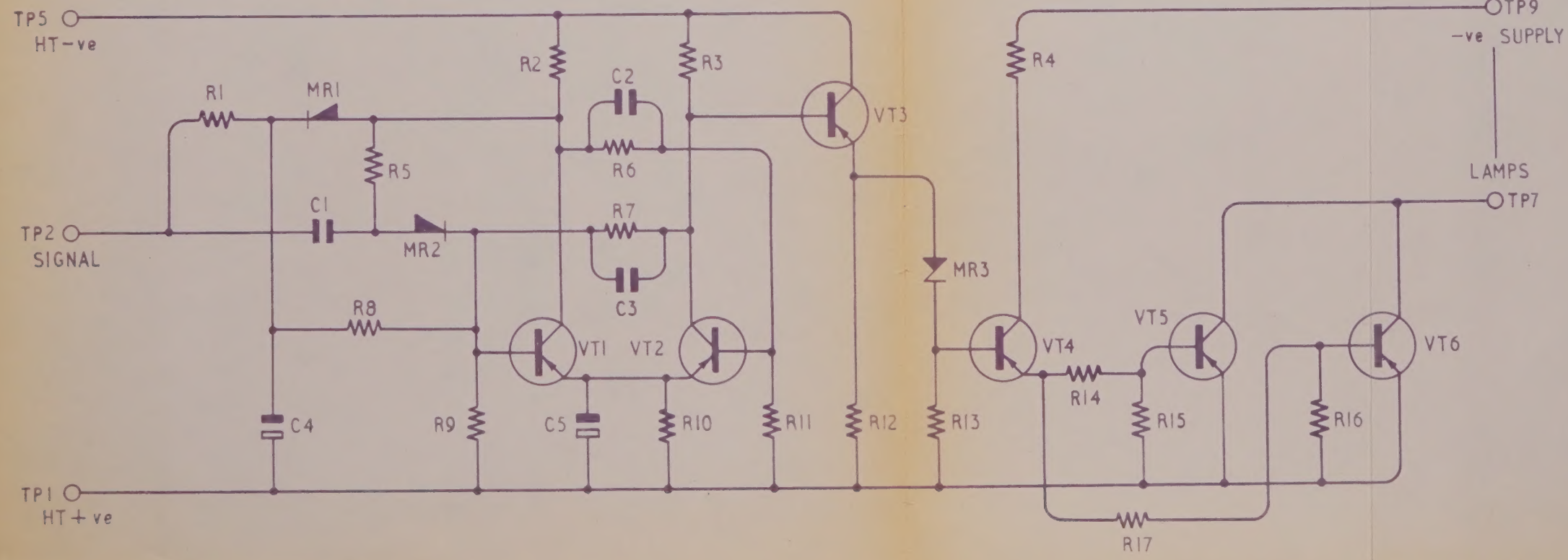
VENNER ELECTRONICS LTD
NEW MALDEN SURREY



POWER SUPPLY GROUP BOARD TYPE TPC 20 **E66/17**
(ISSUE 1)



B.C.D. BUFFER TPC 17 **E66/18**



BLANKING CIRCUIT UNIT TYPE TPC34 **E66/9**
(ISSUE A)

E66/9
E66/17
E66/18

www.manualsplus.com
1004080